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JULY, 1921.

PRINCIPAL CONTENTS.

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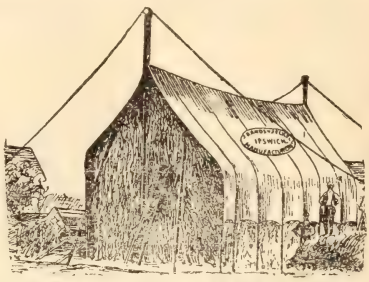

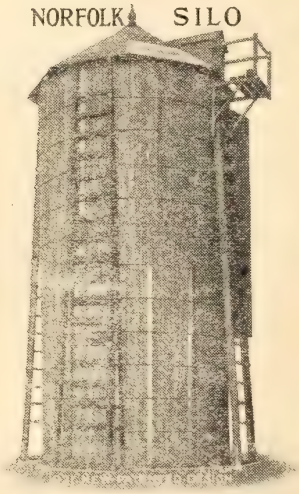

THE JOURNAL
OF THE
MINISTRY OF AGRICULTURE

Vol. XXVIII. No. 4.

JULY, 1921.

NOTES FOR THE MONTH.

Proposed Repeal of Part I of the Agriculture Act, 1920.

In the House of Commons on 8th June, Lieut.-Col. the Right Hon. Sir Arthur Griffith-Boscawen, M.P., Minister of Agriculture, made the following announcement:—"The Government have been carefully considering for some time past the operation of the Agriculture Act, and have come to the conclusion that the financial liability on the State under Part I of the Agriculture Act is more than the country can afford under present circumstances, and consequently that there is no alternative but to terminate at the earliest possible date the policy guaranteeing minimum prices for wheat and oats. This decision involves also the repeal of the provisions relating to the minimum wage for agricultural workers and to the control of cultivation by the State, which are contained in Part I of the Agriculture Act and in the Corn Production Act. I may add that payments will, of course, have to be made in respect of the wheat and oats which will be harvested this year."

The attention of farmers is particularly directed to the final sentence of the above statement, from which it will be seen that payment will be made in respect of wheat and oats harvested in 1921.

* * * * * *

Third Meeting of the Council of Agriculture for England.

The Third Meeting of the Council of Agriculture for England was held in the Council Chamber of the Middlesex Guildhall, Westminster, on 27th May, the Earl of Selborne, K.G., G.C.M.G., being in the Chair.

The Rt. Hon. Lt.-Col. Sir Arthur Griffith-Boscawen, M.P., Minister of Agriculture, and the Earl of Ancaster,

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Parliamentary Secretary, were also present, and the Minister addressed the Council upon the subject matter of the two resolutions first taken.

The first resolution proposed to set up a committee to consider the constitution and mode of election of the Agricultural Advisory Committee, but was not passed, consideration of the matter being adjourned for twelve months.

A resolution on the subject of land reclamation was passed to the effect that, with the object of increasing the country's food production, the Government should be requested to initiate schemes when a time opportune for undertaking land reclamation had arrived. The question of the powers of Local Authorities to make Orders and Regulations governing the movement of livestock into their areas was discussed and referred to the Agricultural Advisory Committee.

The refusal of the Government to finance small drainage schemes under Sections 15 and 16 of the Land Drainage Act, 1918, was also considered, and a resolution was passed requesting the Treasury to reconsider its decision, especially in cases where it could be shown that such schemes are urgently necessary for land improvement and food production.

Sir Lawrence Weaver, on behalf of the Ministry of Agriculture, promised to include in the next Annual Report upon Allotments a return giving particulars in regard to land held by allotment-holders in each County Borough, Borough and Urban District Council on the 31st December last. An amendment that the information should be given for the previous three years also, if possible, was subsequently passed.

The question of railway facilities for handling perishable produce was raised in two resolutions to the following effect:—(1) That during the soft fruit season for a period of not less than five weeks in each year all railway goods stations handling substantial consignments of soft fruit should be kept open for this purpose for the same hours as before the War; and (2) That in the opinion of this Council all railway goods stations at which perishable produce is dispatched or received should be connected to the public telephone forthwith. Both were carried.

The final resolution dealt with the question of the retention by the Ministry of a woman officer for women's work in agricultural districts. It ran as follows:—" That this Council, while fully approving the action of the Government in reducing

the staffs of all departments with a view to economy, desires to urge that, having regard to the organisations now existing throughout the agricultural districts of the country for enlisting the interests of women in the reconstruction of rural life and rural industries, it is essential that the Ministry should retain a woman officer on its permanent staff." With the substitution of the word " advisable " for " essential " this resolution was carried by 17 votes to 12.

* * * * * *

Home-grown Wheat Prices for July, 1921.

IN the May issue of this JOURNAL, particulars were given of the arrangements made as regards the price of home-grown wheat of the 1920 crop, and in the issue for June it was stated that for the month of June the average price properly receivable by growers was 86s. 6d. per 504 lb.

The Ministry is now informed that the Royal Commission on Wheat Supplies calculate that the cost of wheat imported during April, May and June was equivalent to 82s. per quarter of 504 lb. for home-grown wheat of sound milling quality. For the month of July, 1921, therefore, the average price properly receivable by growers for home-grown wheat of sound milling quality will be 82s. per 504 lb.

* * * * * *

Reconstitution of the Horticultural Advisory Council.

THIS Council, which was first appointed during the War to advise the Ministry in regard to important horticultural questions, mainly of supply and prices, has been re-constituted and the number of its members reduced. On the formation of the Council, it was found necessary to appoint individual horticulturists whose opinions on the many and varied questions of the day were of weight, so that the Ministry might be in possession of the views and experience of men from all over the country.

Since the War and with the appointment of a Controller of Horticulture from the industry itself, however, it has become obvious that the Council was too unwieldy for present purposes. Further, the money at the disposal of the Department for the necessary expenses of the Council did not make it possible to call the Council together more than a very few times a year. The Department no doubt suffered on this account through the absence of full and direct contact with the

industry, especially before the appointment of the present Controller.

The scheme of reconstruction now approved requires that the members of the Council shall in future be appointed as representatives of particular interests or associations except in the case of the nominees of the Ministry. Members will accordingly be nominated by the following bodies or interests:—The National Farmers' Union, the Federation of British Growers, the Horticultural Trades Association, the Lea Valley Growers, the National Union of Allotment Holders, the Royal Horticultural Society, the National Federation of Fruit and Potato Trades Associations, the Retailers' Association, and the National Federation of Retail Fruiterers, &c., Limited, the British Florists' Association, the National Seed Trade, the Worshipful Company of Fruiterers, the British Fruit Preservers, the Cider Manufacturers, the Workers' Union, the National Union of Agricultural Works, and the Chamber of Horticulture.

This alteration will without doubt strengthen the Council and give added value to its advice on horticultural questions. In future, it will speak as a duly elected body of representatives covering the whole industry, and will be to some degree comparable with the Council of Agriculture for England, which was set up by the Ministry of Agriculture and Fisheries Act of 1919 to give advice on general agricultural matters. The number of members of the old Horticultural Council is cut down by nearly a half, and the economy resulting from this change, quite apart from the other advantages arising from it, will be considerable.

* * * * * *

Renovation of Farm Orchards.

THE West of England Farm Orchards Committee, appointed by the Ministry and attached to the Agricultural and Horticultural Research Institute, Long Ashton, Bristol, carried out in the autumn of 1919 an exhaustive survey of a total of 531 farm orchards in Devon, Gloucestershire, Somersetshire, Wiltshire, and Worcestershire, and, as a result of their investigations, recommended, *inter alia*, that demonstrations in orchard renovation and management should be given at suitable centres in each county. The Ministry has accordingly suggested to the County Committees of the West of England that they should take over some neglected grass orchards and renovate them, in order to demonstrate to farmers and others what can be done in this direction.

In arranging for such demonstrations Committees should, as far as possible, work on uniform lines. The selected orchards should be in districts where old orchards are plentiful; they should also be of average size, and near main roads. They should either be farmed by an owner-occupier or held under a lease, and, as a general rule, should be taken over for a period of not less than ten years. An agreement should be drawn up, and the consent of the landlord, as well as the tenant, obtained, so that in the case of any change of tenancy the work can be continued by the incoming tenant. The agreement should make the occupier responsible for the labour for carrying out the manual operations involved (planting, fencing, staking, pruning, heading back, top-grafting, spraying, grease banding, picking, storing, grading and packing, marketing, &c.) under instruction from the experts of the County Committee. These would be assisted by the County Committee and by the West of England Farm Orchards Committee acting in an advisory capacity.

The County Committee would undertake to supply to the farmer at cost price any new trees or grafts that may be required. These probably could be obtained from the Ministry's Research Stations at East Malling, Kent, or Long Ashton.

Under such a scheme the occupiers would supply the material for demonstrations and labour, while the County Committees would supply expert technical knowledge and direction for carrying out the work. It should be found, after a period of years, that orchards had increased their out-put many times over; and the owners and occupiers, besides reaping this advantage, would have the satisfaction of helping the district to acquire much useful knowledge, which should be of distinct commercial advantage.

The following is a list of the varieties of apples recommended for planting in the neglected orchards selected for demonstration:—

Dessert varieties.	*Culinary varieties.*
Allington Pippin.	Anne Elizabeth.
King of the Pippins.	Edward VII.
Blenheim Orange.	Warner's King.
Worcester Pearmain.	Bramley Seedling.
	Newton Wonder.
	Underleaf.
	Scotch Bridget.

* * * * * *

Prices and Supplies of Agricultural Produce in 1920.

PART III of the Agricultural Statistics for 1920, which deals with the Prices and Supplies of Agicultural Produce during last year, has now been issued by the Ministry.* The Report refers to the continuance in 1920 of the rise in price of farm produce and of farm requisites which has been a feature of agriculture since the outbreak of war in 1914. In the case of certain commodities such as barley, oats, milk, cheese, potatoes and hay the maximum was reached in the early months of the year, and was followed by a substantial decline, whilst the prices of live stock and meat tended to rise. Feeding stuffs were only obtainable at very high prices during the greater part of the year, though in November and December a fall took place, and the prices of fertilisers were generally higher in 1920 than in 1919. On the average the prices of agricultural produce were 22 per cent. higher than in 1919 and some 192 per cent. above the mean of the three years 1911-13, while feeding stuffs were about 173 per cent. and fertilisers about 159 per cent. above the pre-war level. The average increase in the cash wages of agricultural labourers since the beginning of the War cannot be less than 180 to 190 per cent.

The general inference drawn from these figures is that while the gross agricultural receipts from sales of produce must have grown substantially, there has also been on the other side of the account a great increase in the cost of production. Part of the increased receipts must have been absorbed by the increased outlay on feeding stuffs, fertilisers, machinery, implements and seeds, in addition to the higher cost of labour, both regular and temporary. Other charges which have to be met out of receipts include interest on capital, rent and local rates.

The balance remaining after meeting all charges represents the remuneration for the labour, skill and experience of the occupiers of the 400,000 holdings in England and Wales. What is the extent of this balance cannot be estimated, but it need not be disputed that during the last six years farming has been more profitable than it was before the War. Formerly it was one of the least remunerative of occupations, and just as the wages of farm workers were unduly and unreasonably low, so the net return obtained by a substantial proportion of occupiers was relatively far less than the profits obtained in other industries involving the investment of similar capital.

The Report deals in detail with the prices and supplies of the

* Agricultural Statistics, 1920, Vol. LV, Part III, obtainable from H.M. Stationery Office, Kingsway, W.C.2.

principal classes of agricultural produce, feeding stuffs and fertilisers. Tables are included giving the imports of agricultural produce and requirements, the acreage and production of the chief grain crops, and the numbers of live stock in British Dominions and foreign countries.

* * * * * *

New Seed Regulations.

SINCE January, 1918, it has been necessary, under the Testing of Seeds Order, 1918, in the case of a sale of all the principal kinds of Grass, Clover, Field and Garden Seeds, for the seller to give a declaration with the seed as to its percentage of germination, percentage of purity, the presence of injurious weeds, and various other specified particulars. This Order was the first measure passed in this country for the purpose of controlling the sale of agricultural and garden seeds, and brought us into line with most of the countries on the Continent, the United States of America, and several of the British Dominions and Colonies, where, for a number of years, various regulations for the purpose of preventing the sale of seeds of low vitality and badly contaminated with injurious weed seeds have been in force. The success which has attended the operations of the Order, which was passed under the Defence of the Realm Regulations, and was therefore in itself a transitory measure, indicated the desirability of making its requirements permanent. This has been effected by the passing of the Seeds Act, 1920, which supersedes the Testing of Seeds Order, 1918, and comes into operation on the 1st August next.*

As in the case of the Order, the main requirement of the Act is that a declaration as to quality shall be given in the case of all sales of the principal farm and garden seeds. In the case of sales of seed potatoes, a declaration as to the class, variety, size and dressing will also be necessary, and the sale, or sowing, of seeds containing above a prescribed percentage of injurious weed seeds is prohibited. A further important innovation which will come into operation under the Act is that, in the case of seeds other than garden seeds, the test for the purpose of ascertaining particulars to be declared by the seller must be carried out at an Official Seed Testing Station, or at a private Testing Station licensed by the Ministry of Agriculture for that purpose. After the 1st August therefore, a

* The provisions of the Testing of Seeds Order, 1918, were given in this *Journal* for July, 1918, p. 477, and the main provision of the Seeds Act, 1920, in this *Journal* for October, 1920, p. 604.

declaration based on a test carried out at a non-licensed station will be illegal.

For the purpose of allowing a certain amount of elasticity to the requirements under the Act, the Ministry is authorised to issue Regulations with regard to details. The first set of Draft Regulations has now been prepared in consultation with all the interests concerned. These Regulations prescribe:—

(1) The Seeds to which the Act shall apply.
(2) The particulars to be given in the case of a sale or exposure for sale of seeds and seed potatoes.
(3) The Injurious Weed Seeds to which the Act shall apply.
(4) The method in which Samples must be taken for the purpose of testing.
(5) The Form of Certificate to be issued by the Official Seed Testing Station.
(6) The authorised Minimum Percentage of Germination which, in the case of certain kinds of seeds, may be declared instead of the actual percentage of germination.
(7) The limits of variation in respect of the percentage of germination and of the percentage of purity which are permitted for the purpose of any legal proceedings on a contract for the sale of seeds.
(8) Various other matters which, under the Act, have to be prescribed.

The main provisions of the Draft Regulations, which will remain in draft form for a period of 40 days from 10th June, after which they will be made and presented to both Houses of Parliament, are given at p. 370.

* * * * * *

Seed Testing Conference at Copenhagen.

THE Third International Seed Testing Conference was held at Copenhagen during the week ending 11th June. Seventeen countries were represented, chiefly by the Directors of Official Seed Testing Stations, and four delegates were present on behalf of Great Britain. The papers discussed dealt in the main with purely technical questions, but some of the proceedings were devoted to questions of the control of seed supply, both legislative and voluntary. Sir Lawrence Weaver communicated a paper on The British Seeds Act, 1920, and at the close of the Congress moved the following resolutions, which were unanimously adopted:—

(1) That an Association of Official Seed Analysts and Seed Control Organisations of Europe be formed.

(2) That a Committee consisting of Dr. Volkart, Mr. Bruijning, and Mr. Dorph Petersen (Directors of the Swiss, Dutch, and Danish Official Seed Testing Stations respectively) consider the constitution of the Association, rules of its membership and work, and circulate their recommendations to the members of the Conference.

(3) That the same Committee should consider—

(*a*) the unification of seed-testing methods in Europe, keeping in view the possibility of ultimate unification with North America;

(*b*) the method of expressing the results of analysis and the quality of the seeds analysed;—

and present a report to the next International Conference.

(4) That on the invitation of the Minister of Agriculture and Fisheries the next International Conference be held at the end of June, 1924, in England, partly in London and partly in Cambridge.

A more detailed account of the proceedings of the Conference, by Mr. C. B. Saunders, Chief Officer of the Official Seed Testing Station for England and Wales, will appear in a later issue of the JOURNAL.

A COURT LEET.

The Earl of Selborne, K.G., G.C.M.G.

If the Law of Property Bill now before Parliament becomes an Act, one result, so I am told, will be that Courts Leet, which have existed in England almost from time immemorial, will cease to be held. I was very glad therefore to have the opportunity of attending two such courts lately, each held in the best room of the public house of a beautiful Dorsetshire village. I had never attended such a court before and was curious to see what happened. I cannot say that the business transacted, though necessary, was very important, but it was transacted with much formality according to the ancient observances.

The Steward of the Manor commenced the proceedings by reading a document which began "Oh yes, Oh yes, Oh yes," and, as he read a sentence, the predestined foreman of the jury repeated it after him. The foreman of the jury was then sworn on the New Testament in very thorough-going fashion and after him the four other members of the jury swore "to do the same things and in the same manner as our foreman has sworn." The Steward then read a formal address to the jury and asked them for their "presentations." In one case the important matters were the state of the ditches, watercourses, sheep dips, and sinkholes. In the other case memories were racked to present a correct list of the deaths of copy-holders (and, more important still, of persons by whose lives copy-holds were held) which had taken place since the last court was held in May, 1920.

Three clear impressions remain with me from my experience.

The dignity and gravity with which these proceedings were conducted reminded me once again what a strong instinct of ritualism is really latent in the English character. I have noticed it again and again at the functions of the Friendly Societies, when the members, all agricultural labourers, mechanics, tradesmen or farmers of some South country village, dress themselves up as elaborately as a Knight of the Garter for a Chapter at Windsor, and wear these strange garments all through a hot summer afternoon with an ease and unconscious dignity which might well be envied by a Knight. But one day I was myself initiated into one of these great Societies, and it is not an exaggeration to say that the ritual of that "initiation" equalled anything that I have seen at a State function of any sort, or even at High Mass on some special occasion in a Roman Catholic Church in France or Italy.

On this occasion there were no dresses, scarves, or regalia, but there was an elaborate formality and an ancient liturgy which were scrupulously observed. One juror told me that he had attended this Court for forty years without a break and that as long as he could drag one leg after the other he should not think of missing it. And yet there are people who would ask you to believe that tradition and conservatism of personal habits are intellectual funguses, which cling only to the superannuated squire or farmer and which are unknown to the up-to-date trades unionist agricultural labourer! What nonsense some people who live in towns, do talk about us, who live in the country!

Among the jurors of these courts and other inhabitants of these two small villages, whom I met later, were four farmers, all of whom had started life as agricultural labourers. One of these, a man of not more than 50 years of age, occupied 1,000 acres, of which half was down and the other half meadow and arable. The other three occupied farms of 50 to 150 acres. This experience quite confirmed all my previous experience. I have never known a country district or anything definite about a country district without meeting case after case of the farmer who began life as an agricultural labourer; and, if this is true to-day, is it not probable that it was true yesterday and therefore that some of the farmers I see and meet are the sons of men who began life as agricultural labourers, and so back generation after generation. And if this is true of those parts of England, of which I know something definite or which I know intimately, surely it would be strange if it were not true of the other parts of England also, which I do not know!

The truth is that the agricultural labourer is not born in a cul-de-sac, as some people contend, and never has been. There never has been a time, I suspect, since all Englishmen became free men in the full sense of that term, when an agricultural labourer of marked character and ability could not rise to become a farmer, and I suspect that the cases in which he has done so within the last century have been much more numerous than is generally supposed. This is not an argument for not making the path easier for the agricultural labourer to become an occupier and owner of land by every sensible means in our power—on the contrary, it is a very strong argument in favour of the wisdom of such a course. But it is an equally clear disproof of the statement often made that the agricultural labourer was reduced to such a position in the 18th century that it was impossible for him to rise out of it except by

deserting his own countryside for the towns or for the Colonies. It is also true that all the time the most fit of the agricultural labourers have been rising, the least fit of the farmers and of the landowners have been falling. When such a family comes down in the world its members have a tendency to leave the old neighbourhood for the towns or the Colonies, but I have myself known agricultural labourers whose forefathers were farmers, and I have heard of others whose forefathers were the owners of the land on which they worked. This process of natural selection is surely healthy for the countryside so long as it is not stimulated and made unnatural by the operation of unwise or oppressive laws.

My third impression was that a worse form of tenure than a copyhold for lives has never been invented by the laziness of man. For consider how it operates—a copyhold is held for three named lives from the lord of the manor. The holding must have started some time or other, and then presumably the first copyholder paid a handsome sum to the lord of the manor, in return for which he was allowed to name three persons, and then for as long as one of those three was alive he could not be called upon to pay any rent for the land, though he had to make certain comparatively small payments on stipulated occasions. The lives named were sometimes those of local persons and at other times members of the Royal Family or of well-known public character. The Duke of Connaught's name, I was told, was often to be found in connection with these Dorsetshire copyholds. When one of these lives died the copyholder asked to be allowed to name another, for which privilege he was prepared to pay a comparatively large sum down. For the lord of the manor, who was the real freeholder, this was a preposterous system. In the course of years it meant receiving occasional lump sums down and the loss of an annual economic rent which would have added up to a far larger sum. He was also relieved of all responsibility for the land or buildings and cottages, and could not interfere with the copyholder's treatment of the land or cottages.

For the copyholder this would have been a very profitable bargain if he could have been assured of its perpetuity; but a day came when the lord of the manor returned to sanity and refused to renew the lives, determined to regain control of his own land when the last life lapsed, to put his property into proper order and to let the farm at an economic rent. But from the moment that he received the refusal of a renewal of

lives, the continuous interest of the copyholder in the land he held ceased to exist, and in too many cases from that moment he began to grudge the expenditure of a penny on the repair of cottages or buildings or fences or gates, and the annual sum disbursed on the necessary repairs dwindled to a vanishing point as the years went on and the lives became older.

Sometimes it happened that the last two lives lasted on many years and the lord of the manor had to look on impotently while he saw good cottages and substantial farm buildings melting away into deplorable ruins. And the urban critic came down and was righteously indignant at the state of the cottages, and demanded the name of the local magnate and went away and denounced him, and had no suspicion that the real responsibility for the wretched cottages rested with a man who lived in one of them and for the wretched system with men who had been dead for centuries.

THE DAIRY SHORTHORN.

ROBERT HOBBS, Kelmscott.

THE economic value of a dual-purpose breed of cattle to the community as a whole would appear to be in some danger of being overlooked, and the tendency at the moment is rather to consider the merits of such cattle from the point of view of the individual farmer. Writing, however, as one whose father and grandfather both demonstrated the great value and, in certain circumstances, the indispensability of dual-purpose cattle, I find that thirty years' personal experience, emphasised particularly during the last seven years, has but served to strengthen my conviction that, to serve a densely populated country, dual utility cattle are one of the supreme factors in the production of the three great food essentials—grain, meat and milk, with the products of the latter, cheese and butter.

To-day no country with any economic self-respect is content to take the native breed of cattle as good enough for its own particular needs; it demands something capable of meeting, in the greatest possible degree, the requirements created by climate and its peculiar social conditions. Thus it is to be understood that in new and therefore undeveloped countries, where vast tracts of land are to be had at merely nominal values, as in the wheat-growing districts of the United States and Canada and the grazing ranches of Argentina, beef production and grain crops are the predominant considerations with the agriculturist. In Argentina, in point of fact, milk production beyond the level necessary for the rearing of the calves born on the ranches is regarded in the light of a nuisance. On the other hand, in the dairy districts of Australia and New Zealand, beefing qualities are almost entirely ignored. So long as the regions immediately adjoining these, agriculturally speaking, "single-purpose areas" undergo no further development the single aim remains, but the moment the surrounding country makes appreciable industrial growth the agricultural development takes another course. It may almost be said that it is not until the population increases greatly and large cities make their appearance that the proper development of agriculture commences. The first consequence of industrial extension upon the farming of the district is an attempt to meet the demand for cattle which are capable of

producing a good yield of milk, calves suitable for grazing into bullocks of high quality, and a good carcass of beef at the end of their milking days.

It is not surprising, therefore, to find that the popularity of an animal meeting these needs so well as the Dairy Shorthorn is extending far beyond the United Kingdom, where it has held sway for upwards of a century as the farmer's cow, and is penetrating deeper and deeper into the newer countries of the world. Especially is this extension to be noticed in the more thickly populated districts of the Eastern States of America, in South America, South Africa and New Zealand, and, in fact, in most parts of the world where population is growing at a greater rate than the production of food.

At home the Dairy Shorthorn has successfully passed through times of difficulty and some danger. At no period was its future more seriously threatened as a double-purpose animal than during the earlier days of the demand from Argentina for heavily-fleshed Shorthorns. The high prices then paid, and the particular type which was bred in consequence, were responsible for the disregard of the milking qualities which, even among the very early improvers of the "Durham," were so characteristic of the breed. The danger increased when there began the indiscriminate crossing of heavy milking English cows with the thick-fleshed Cruickshank bulls. Fortunately this menace to the future of the breed was recognised in time by a few enthusiasts, by whose efforts the Shorthorn was saved from becoming primarily a beef animal. These breeders succeeded in persuading the Shorthorn Society to offer prizes at the principal agricultural shows throughout England, Scotland and Ireland for pedigree Shorthorn dairy cows; then they formed the Dairy Shorthorn Association and secured affiliation with the Shorthorn Society. Milk recording in pedigree herds was encouraged, but the most important step in the history of the Association will probably prove to be the publication of the Register of Non-pedigree Dairy Shorthorns whose progeny may gradually qualify for admission to the Herd Book. By these measures the heavy milking powers of the breed were rescued from the neglect which at one time seriously threatened them.

The Government Live Stock Improvement Schemes, including the grants through the Ministry of Agriculture for encouraging the breeding of high-class commercial stock, with separate grants to the Milk Recording Societies, have

also afforded a valuable stimulus to the breeding of well-fleshed bulls from milk-recorded cows, with the result that the importance of the dual utility animal, and the extent to which the Dairy Shorthorn answers the need for it were never more deeply appreciated. It may be of interest to point to the growth of the Dairy Shorthorn Association. In 1914 it comprised 214 members, with 55 herds and 337 milk records. In 1920 the membership had risen to 631, the herds to 332, and the milk records to 1,194. In December, 1918, the Association published the first volume of the Register of Non-pedigree Shorthorn Dairy Cows, in which close upon a thousand approved milking Shorthorns were enrolled as foundation cows. The Register and the milk recording scheme have naturally led to the improvement of prices for non-pedigree cattle with milk records, and herds have been dispersed at an average of from £107 to £114 per head, with individual prices up to 270 guineas.

A word of warning may not be out of place in view of the rapid extension of the milk recording system. Here and there a tendency may be observed towards pushing milk production to excess. What is needed most of all is a gradual raising of the standard of breeding and management, and an improvement in the methods of feeding, so as to enable the production of the greatest volume of milk consistent with the lowest economic cost, and without placing an undue strain on the cow. At the recent sales of recorded cattle there have been signs that these points are realised by a very large body of farmers and breeders, for there has been a steady demand for the right sort of cow. It appears to be recognised by a large number of farmers that the cow as a mere milking machine is a risky proposition, and this risk, in conjunction with the extravagant cost of maintenance both in food and labour, and the general inability of the calves bred from such cows to grow into profitable feeders, has affected the demand for the "shelly" cow. To command the highest market figure to-day the cow or heifer must be wide, deep and level, of good Shorthorn character, carrying a square, well-hung bag with well-placed teats of medium size, being neither too short nor coarse or "bottled." The demand for this class of animal is practically insatiable, and in consequence such cows top the ordinary market price in no matter what part of the country they are offered.

The breeding of Dairy Shorthorns offers many advantages

to the ordinary beginner with a limited amount of capital. In the first place the breed is the most widely-found of all breeds, and is the popular general purpose animal in practically every county of England or Ireland. This ensures that wherever they may be bred there is always a market, whether for calves, young stores, down calvers, or fat beasts.

A second advantage is that it is immaterial whether the beginner is farming a grass farm, a mixed farm, or a farm wholly arable, for the dual-purpose Shorthorn is at home on either one or the other, and is quite adaptable to the feeding and management in either case. Nor does it matter to the owner of the Shorthorn in what form he is marketing his milk product, whether as whole milk, cheese, or butter.

Further, the Shorthorn is the only established breed of cattle remaining in this country which still has an open herd book, and if the embargo on foreign cattle continues, there is little fear of the Shorthorn Herd Book being closed for many years. Apart from any other consideration, this is of tremendous advantage to beginners, and although the Shorthorn Society still requires four crosses from a foundation dam of Shorthorn type before accepting heifers for entry in Coates's Herd Book, registration may now begin in the Dairy Shorthorn Register as soon as an approved cow has yielded 8,000 lb. in one year or 6,500 lb. a year for two consecutive years, provided she is of a suitable Shorthorn type. Thus the beginner's interest, as well as the enhanced value of the cow and her offspring, commences at once, and he may safely add an average of from £5 to £10 in value for each pure cross by a pedigree Shorthorn milk bull on heifers descended from these registered cows, until the descendants in the fourth generation become eligible for the Herd Book proper. After this has been achieved, with sufficient good looks and sound records behind them, there is no reason why they should not, in many instances, realise very high prices and produce valuable breeding animals.

THE "BUCKEYE" DITCHER FOR LAND DRAINAGE: TRIAL IN CAMBRIDGESHIRE.

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MANUAL labour in digging and laying drains on stiff land last winter probably cost about £15 per acre. Expenditure on this scale, coupled with the long period required to complete the work, and the increasing difficulty of obtaining skilled men to carry it out, is doubtless preventing much tile drainage from being undertaken. The question therefore arises whether some type of draining-machine can perform the excavating work in an economical and satisfactory manner.

An American machine, the "Buckeye" Traction Ditcher, recently imported by the Scottish Board of Agriculture, was reputed to have been highly successful in Scotland, and more detailed information with regard to its capabilities was felt to be necessary. The Ministry of Agriculture and Fisheries therefore arranged for the loan of the "Buckeye" Drainer from the Scottish Board for a trial on Sir Douglas Newton's estate at Croxton, Cambridgeshire.

The "Buckeye" arrived at St. Neots station on August 18th, 1920, and travelled to Croxton Park by road under its own power, a distance of about 4 miles. The trial lasted for three weeks and included a public demonstration on September 3rd; during this time the machine was under the writer's observation.

Description.—Ditch tractors follow in principle the methods adopted in the construction of rock and earth excavators used by railway and mining contractors. They are made on one of two systems—buckets mounted on a rotating wheel or buckets carried on a moving endless belt. The "Buckeye" Tractor Ditcher described here is designed on the rotating wheel system, and the following is an abridged specification :—

20 h.p. four-cylinder petrol engine.

Digging wheel	11½ in. or 14½ in. wide × 4½ ft. deep. or 11½ in. wide × 5½ ft. deep.
Length over all	25 ft.
Width over wheels	8 ft. 6 in.
Extreme height	8 ft. 9 in.
Digging speeds	2½ ft. to 9 ft. per minute.
Road speeds	1 to 1½ miles per hour.

Approximate shipping weight ...	7-9 tons.
Width of front wheels	10 in.
Width of extension tyres to front wheels	8 in.
Width of caterpillar track	22 in.
Centre of ditch to centre of spoil bank	4 ft. 3 in.

The chief points of the machine may be briefly outlined as follows:—

A substantial main frame and platform constructed of steel I-beams connected at intervals by cross beams and strongly reinforced, carries at one end a 20 h.p. engine unit and transmission system, and at the other the cutting wheel hinged to the platform. The frame and superstructure are supported at both ends on three-point suspension trucks which eliminate severe twisting strains. The front truck carrying the engine is mounted on two heavy wheels; the truck carrying the rear of the frame is supported by large rollers, with case-hardened shells and chilled bearings, running on a jointed steel caterpillar track, the treads of which are of steel plate and hard wood, driven by endless chains running over sprockets. The large bearing surface afforded by these tracks minimises the pressure per square foot and enables the excavator to travel over soft ground.

The digging wheel is mounted midway between the two main girders and is held in a three-point suspension frame hinged to the main platform. Power is transmitted to the wheel by a system of chains running on sprocket wheels; and by shifting a high speed chain from one set of a series of graduated sprockets to another, four digging speeds ranging from 2½ ft. to 9 ft. per minute can be obtained. The machine is, of course, stopped to move the chain, but the plan is found to be highly satisfactory and effective.

A feature of the transmission system is a safety device in the form of a friction cone clutch, which slips when the machine strikes an obstruction beyond its capacity, thus averting a breakdown. On the outside rim of the digging wheel are mounted buckets of deep section which can be suitably equipped for varying classes of work. For digging in stony ground, picks are attached to the rims of the buckets, and the back of each bucket is closed by a removable plate. In dry sands the picks are replaced by curved cutting extensions, and the backs are retained. In wet clays the cutting extensions are employed, but the backs are removed, and the buckets are cleared as they revolve by a set of iron fingers held rigid on the wheel-frame, which pass through each bucket

in turn and scrape out the clay. In all cases the excavated earth falls on a rotating clearing canvas and is deposited in a neat pile alongside the trench.

Adjustment of the depth of the digging wheel is obtained by a hoist worked from the engine and operated through a double boom, the cables communicating with both the front and the rear of the wheel-frame. If the digging wheel is rotated and lowered, keeping the forward end of the wheel-frame some 3 ft. lower than its rear end, the buckets will dig themselves into the ground at this angle as the whole machine is advanced. At some prearranged depth the descent is checked by means of the front cables; the rear cables are then slackened, allowing the curved sole which follows the digging wheel to take the weight of the rear of the wheel and thus mould and smooth the floor of the trench.

The method of adjusting the depth of the trench, in order to obtain a drain of even fall when the machine passes over uneven land, is of such practical importance that it may be described in some detail. The system is shown diagrammatically in Fig. 4, in which A B C represents an irregular surface below which the drain has to be cut. At intervals of about 50 yd. along this line, levels are taken in the usual way. Having decided the fall required in the drain, the depths below the surface at which the floor of the trench must lie at A, B and C are calculated. Suppose these depths are 4 ft. 6 in., 3 ft. and 4 ft., respectively, as in the diagram (where F G represents the bottom of the drain and F H the horizontal). The next operation is to erect standards fitted with movable cross-members at A. B and C. The cross-members must be adjusted in correlation with a horizontal sighting rod D fixed to the frame of the digging wheel E of the drainer. If this sighting rod is fixed 9 ft. above the lowest part of the wheel, it is then 9 ft. above the floor of the drain, and the cross-members on the standards must be so fixed that they, too, are 9 ft. above the level at which the floor of the drain is to be dug. Thus the cross-member at A will be 4 ft. 6 in. above the ground, that at B will be 6 ft. above the ground, and so on. The cross-members must be all in line, since the drain is to be cut with an even fall. The machine is then moved to the outlet end A of the drain, since digging always proceeds uphill, and made to face along the line of standards. The digging wheel is caused to cut its way into the ground. When the sighting rod intersects the line of cross-members, the further

Photo] [*Albone, St. Neots.*

FIG. 1.—The machine at rest.

Photo] [*Albone, St. Neots.*

FIG. 2.—The machine at work.

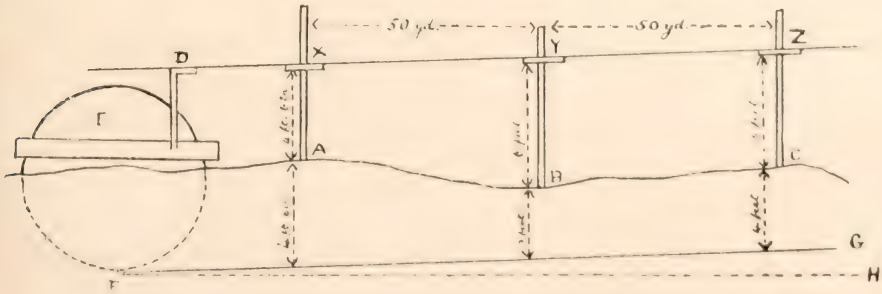

FIG. 4.—Diagram showing the method of adjusting the depth of the trench when the machine passes over uneven land.

Photo] [*Albone, St. Neots.*

FIG. 3.—Back view of the machine when at work.

descent of the wheel is stopped by the winding gear, as previously described, for the bottom of the wheel has now reached the level of the floor of the trench. The drainer now proceeds along the line of the proposed drain, and the driver must keep the sighting rod constantly in alignment with the cross-members by raising or lowering the digging wheel in accordance with any irregularities of the land. If this is done carefully, a trench with an even fall can be excavated in one operation. It must be emphasised that any carelessness in the matter of sighting will involve subsequent grading of parts of the trench by hand: this actually occurred on several occasions during the trial.

Organisation.—Before the arrival of the machine, a scheme for the drainage of the land should be decided out, preferably with the assistance of a surveyor, who will mark out on the ground the position of outfalls, mains and minors, take levels at suitable points along the various drains, placing in the ground pegs bearing the number of feet above the surface at which the cross-member should be placed at each point to give the correct fall in the drain.

The staff required by the machine consists of two men—a driver, who must be a skilled mechanic, and an assistant. Although one man can run the machine if all goes well, the other must be immediately available to attend to the sighting rods and to assist in case of repairs. With this arrangement the men could work in shifts if long running hours were desired.

When the drainer arrives, the surveyor should explain to the driver the plan of the proposed drains; the latter can then erect his standards and cross-members according to directions left on the pegs, and excavations can be commenced.

A boy should be provided to deal with the small quantity of earth which drops back on to the heel of the machine and thence into the bottom of the trench. He rides in the trench on the extreme rear of the drainer and clears out with a shovel the earth as it accumulates on the heel of the machine. The quantity of earth which finds its way back into the trench can be minimised by fitting to the rear of the machine a metal apron, which brushes loose material from the edge of the excavation. Two types of aprons were tried at Croxton, but neither could keep the bottom of the trench quite clear, particularly when the machine was working at a high speed in loose soil.

Arrangements should be made to lay the pipes close behind the machine, as delay in doing this will probably result in loose earth falling into the finished excavations.

Conditions Encountered.—The soil at Croxton is a stiff boulder clay of considerable thickness which, as explored to a depth of 4 ft. 6 in. by the excavator, contained a few large boulders and bands of chalk pebbles mixed with gravel. In places, however, uniform sticky clay was found to the full depth of the drains.

Fields of two types were attempted:—The demonstration field was a 12-acre bare-fallow of gentle and fairly uniform slope. There was about 5 in. of dry friable soil on the surface, but below the clay was moist and sticky owing to the conservation of water by the fallowing operations. In the upper parts of the field, bands of chalky gravel were found in the clay. The other set of conditions encountered consisted of wheat stubbles; these presented hard-baked clay surfaces resting on dry clay of a type containing rather more chalk and gravel than in the wetter parts of the demonstration field; the comparative dryness of the subsoil here was no doubt due to the absorption of water by the roots of the wheat crop.

The mechanical analyses given in Table I show the nature of the various fields just described. Since the bulk of the earth excavated by the machine consisted of subsoil, the analytical figures for the respective subsoils probably give a

TABLE I, showing percentages of Constituents.

Soil number.	Stones.	Moisture.	Organic Matter.	Fine Gravel.	Coarse Sand.	Fine Sand.	Coarse Silt.	Fine Silt.	Clay.	Chalk.	Total percentage of water at time of excavating.	Area represented by sample.
1	7·0	2·0	6·8	5	8·6	17·9	7·5	14·2	32·0	7·4	14·2	Surface of the stiffer and wetter parts of demonstration field.
2	·4	2·4	8·0	1·1	5·7	12·2	9·5	9·3	35·0	12·3	21·7	Subsoil of above.
3	1·9	2·0	6·6	1·7	15·8	22·5	7·5	10·7	27·0	6·2	10·6	Surface of drier and more chalky parts of demonstration field.
4	8·0	1·3	2·0	·5	9·0	10·1	4·8	5·5	14·0	43·4	16·5	Subsoil of above.
5	2·0	2·1	5·8	·5	10·6	18·8	7·5	15·8	27·6	5·4	16·1	Surface of the stubble fields.
6	3·3	2·1	1·0	3·0	4·5	14·0	6·0	11·0	27·0	27·4	15·5	Subsoil of above.

better measure of the digging conditions than do the figures for the corresponding surface soils. The former will therefore be considered more fully than the latter.

Samples 1 and 2 show clearly the exceedingly stiff and wet nature of the lower part of the demonstration field. The subsoil contains as much as 35 per cent. of clay and 9 per cent. of fine silt, while its water content of 21·7 per cent. is by far the highest of any of the samples analysed.

Soils 3 and 4 indicate that while the surface soil is substantially the same as in the previous case, the subsoil is of an entirely different type, being drier (16·5 per cent. water), considerably more calcareous (43·4 per cent. chalk), and containing a relatively high percentage of stones (8 per cent.).

The stubble fields, as represented by samples 5 and 6, show 27 per cent. of clay and 11 per cent. of fine silt in the subsoil. This denotes a heavy subsoil. On the other hand, the water content of 15·5 per cent. is low, and the amount of chalk (27·4 per cent.) is considerable.

It was subsequently found that the drainer could operate more rapidly at any given depth in a dry clay subsoil containing chalk and gravel than in a wet clay subsoil.

The weather conditions during the trial were very favourable; no heavy rain fell. There were a few showers, but the soil was never soaked, and the machine could always be worked without any risk of damage to the texture of the land.

TABLE II.

Date.	Hours Lost by Breakdowns.	Hours Adjusting and Repairing.	Hours Working.	Gallons Fuel.	Gallons Oil.	Lb. Grease.	Chains 3 ft. 6 in. mains.	Chains 2 ft. 6 in. minors.
19/8/20 ..	1½	3	¾	2½	¾	½	1⅕	
20/8/20 ...	2½	1¼	3	8	1¾	—	6	
21/8/20 ...	—	½	½	1½	—	—	½	—
23/8/20 ...		2	4	11	2	—	6⅕	1
24/8/20 ...	—	½	5¾	11¾	2	½	—	14½
25/8/20 ...	1½	1¾	6	11½	2¼	½	—	21½
26/8/20 ...	—	2¼	5	9½	1¼	¼	—	19⅕
27/8/20 ...	—	2½	4¼	8½	2	5	—	17⅕
28/8/20 ...	3	½	—	—	—	—	—	—
30/8/20 ...	—	5¼	1	4¾	1¾	—	1¼	3
31/8/20 ...	1½	1	3½	7¼	¾	—	8¾	—
1/9/20 ...	—	2½	3⅝	9	2½	¼	12½	—
3 9/20 ...	—	½	6¼	13½	2	—	6	36¼
4/9/20 ...	—	½	¾	2	1¼	—	2⅕	—
6/9/20 ...	—	¾	5¼	13½	1½	—	24*	
7/9/20 ...	1	1	3¼	8½	1	1	4*	21½†
8 9/20 ...	6	—	—	—	—	—	—	—
9/9/20 ...	6	—	—	—	—	—	—	—

* Mains 2 ft. 9 in.
† Minors 2 ft.

Digging Accomplished.—Few who saw the "Buckeye" in operation could fail to be impressed by the way in which it

performed the work. Mains 4 ft. 6 in. deep were dug at the rate of three linear feet per minute in the stiffest and wettest part of the demonstration field. Boulders were either broken down and thrown out in pieces or else raised entire; moist clay was delivered in large lumps; dry clay in small flakes resembling cracked linseed cake.

On the day of the demonstration the machine was working continuously from 10.30 a.m. till 4.30 p.m., and in these 6 hours it completed 6 chains of 3 ft. 6 in. mains and 36 chains of 2 ft. 6 in. minors; the latter were excavated on top gear at 12 ft. per minute. About 200 people visited the ground, and the speed and efficiency with which the work was done was favourably commented upon.

Data Obtained.—In Table II will be found a summarised statement of the observations made during each working day of the trial. A few words of explanation are necessary with regard to the headings of the columns. "Hours lost through breakdowns" comprises the time during which the machine was rendered idle by some part having to be taken to a smithy or repair shop. "Hours adjusting and repairing" represents the time spent on altering the setting of the machine to face new soil conditions, and on minor repairs or replacements performed on the spot, and also includes time spent on oiling, &c., before starting. "Hours working" includes the time when the machine was actually excavating, moving overland from the end of one drain to the beginning of the next, and travelling small distances by farm roads from one field to another. The fuel used was benzol, and, on a few occasions, 2nd grade petrol. The lubricant was heavy cylinder oil. On two occasions, September 6th and 7th, the depths of the drains dug were not as stated at the head of the last two columns; the depth of the mains on these days was only 2 ft. 9 in., and the minors only 2 feet.

As an example of a typical day, August 25th may be quoted. There was a stoppage of $1\frac{1}{2}$ hours for a blacksmith's repair; $1\frac{3}{4}$ hours in minor adjustments in the field; and a period of 6 hours was actually spent in digging $21\frac{1}{2}$ chains of 2 ft. 6 in. minors in stiff wet clay, $11\frac{1}{2}$ gallons of benzol, $2\frac{1}{4}$ gallons of cylinder oil, and about $\frac{1}{2}$ lb. of grease being consumed. August 19th was an exceptional day, when much time was spent in adapting the machine to local conditions. On this occasion the machine followed a curved main, a type of work for which it was not suited, owing to the length of the

sole which travelled in the trench, the result being that only $1\frac{1}{5}$ chains were dug by the use of $2\frac{1}{2}$ gallons of fuel. August 21st and September 4th were Saturdays, when the men ceased work at noon; very little digging was done, and there is no doubt that the figures for these days should not be regarded as true measures of what the drainer could perform in half-a-day under commercial conditions.

It will be observed that four days are unaccounted for in the table. Three were Sundays, and September 2nd was spent in a general cleaning and overhauling in preparation for the demonstration. Three days were completely lost by breakdowns; August 28th was a Saturday, hence only three lost hours are recorded; September 8th and 9th were idle on account of replacing a broken pinion. On September 10th the machine was put on the train for Scotland. If September 8th and 9th, when the machine was idle owing to the broken pinion, be excluded, it can be calculated that the average working day was $5\frac{2}{3}$ hours. Of this, $\frac{2}{3}$ of an hour was lost by breakdowns, $1\frac{2}{3}$ hours by adjustments, and $3\frac{1}{3}$ hours were spent in actual digging.

These figures are disappointing, but it should be realised that conditions of management were exceptional during the trial. Several troublesome stoppages should not have occurred: for example, the machine was put out of action by the dog connecting the magneto shaft to the engine becoming gradually worn out. By careful overhauling it should have been possible to detect the fault and avert a breakdown. It might be said, without labouring the point, that the conditions under which the men were working were not conducive to the biggest output. At the demonstration, when the men were doing their best, the machine dug continuously for 6 hours without a hitch; but admitting that special preparations had been made for that day, there is no doubt that, given stricter supervision or some system of payment by results, the average digging day could have been increased materially.

The consumption of fuel and lubricating oil calculated from the daily figures of the whole trial worked out at an average of $2\frac{1}{3}$ gallons of benzol and $\frac{2}{3}$ gallons of cylinder oil per running hour.

Table III shows the performance of the machine when digging at certain depths in various classes of land. Figures for each type of work were taken from Table II covering as long a period as possible; for example, the four days

August 24th to 27th, inclusive, gave the information concerning the rate of digging 2 ft. 6 in. minors in wet clay. The column headed " Tons of earth excavated per hour " was derived from determinations of the density of the undisturbed soil and the dimensions of the trenches.

TABLE III.

Type of earth excavated.	*Depth of trench.*	*Chains trench dug per gallon.*	*Chains trench dug per hour.*	*Gallons per hour.*	*Tons of earth excavated per hour.*
Moist stiff clay..	3 ft. 6 in.	·64 ch.	1·7 ch.	2·8 gal.	18 tons
Moist stiff clay..	2 ,, 6 ,,	1·76 ,,	3·5 ,,	2·0 ,,	25 ,,
Dry clay with flints and chalk	3 ,, 6 ,,	1·30 ,,	3·0 ,,	2·3 ,,	31 ,,
Dry clay with flints and chalk	2 ,, 9 ,,	1·78 ,,	4·6 ,,	2·6 ,,	37 ,,
Dry clay with flints and chalk	2 ,, 0 ,,	3·41 ,,	9·0 ,,	2·6 ,,	52 ,,

It will be observed that the rate of excavation measured in chains per hour increases rapidly as the trench becomes shallower, the type of soil being the same. This is due not to the machine excavating a lesser weight of earth per hour, for the last column in Table III shows that the weight of earth excavated increases rapidly as the depth of trench decreases; nor is it due to a higher lift, which in each case is the same. The increase in speed with the shallow drains is due in part to lesser friction between the digging wheel and the sides of the trench. Indeed, this friction accounts for a great proportion of the power used in digging, and is well brought out in comparing the rate of digging 3 ft. 6 in. trenches in moist clay at 1.7 chains per hour with 3 chains per hour for trenches of the same depth in dry clay, in which the friction is much less.

The rate of fuel consumption, given in gallons per hour in the fifth column of the table, is roughly constant at all speeds. It varies in fact from 2 to 2.8 gallons per hour. One of the reasons for this constant consumption of fuel is that the machine is fitted with an automatic cut-out, which acts like a governor and causes the engine to run at constant speed.

The table also gives an indication of how much work could be done under the various conditions of depth and soil if it were kept running, *e.g.*, for 7 hours per day. Under these conditions some 63 chains of 2 ft. minors could be dug in

dry clay, or 21 chains of 3 ft. 6 in. mains in similar clay, or 12 chains of 3 ft. 6 in. mains in wet clay.

Mechanical Considerations.—The excellence of the engine and mechanism was remarked upon by all engineers who examined the drainer, and there is no doubt that the machine is well designed for cutting trenches in all classes of land. The engine was designed to burn petrol, which certainly seemed uneconomical in this type of heavy-duty motor. Undoubtedly the cost of fuel could have been reduced by 30 per cent. if an efficient form of vaporiser had been fitted to burn paraffin. The machine was intended primarily for use in America, where distillate is cheap, and probably the manufacturers had not considered the fuel question for England. During the trial second grade petrol and benzol were the fuels used.

The safety device previously described only acted on two or three occasions, for on striking an obstruction the driving chains usually broke (or jumped their pinions) before the clutch slipped. This clutch was undoubtedly out of adjustment, and if it had been attended to there would have been less trouble with the chains, and a fruitful source of minor delays would have been removed.

The width of the trenches dug for the 2 in. tiles was criticised by practical men. It was pointed out that there was too much lateral play in a drain 11 in. wide at the bottom. To remedy this Mr. Thompson Close, the Ministry's inspector, arranged for an iron tile-mould to be fixed to the bottom of the sole of the machine, its function being to make a groove in the floor of the trench of the exact size to take the 2 in. tiles. This was an improvement. In any case, some unnecessary earth is excavated when digging for small pipes, and if the digging width could be reduced to, say, 8 in., which should offer no mechanical difficulties, economies should be effected. On the other hand, very narrow drains, if deep, are difficult for men to work in, should such drains subsequently need deepening or grading before the tiles are laid; again, if wider trenches are dug, a relatively large amount of earth is disturbed, which may give a quicker percolation and render the drains more effective.

The machine was provided with a large assortment of spares, but two breakdowns involving castings necessitated workshop repairs. On four occasions minor jobs had to be taken to the local smithy. In noting these stoppages, however, it should

be remembered that the machine had been in constant and heavy use for the previous eighteen months. Certain delays are to be regarded as of normal occurrence: the sides of the digging wheel had to be cleared of clay from time to time when excavating in wet patches; large stones had occasionally to be dislodged from the buckets; worn links had to be replaced in the driving chains; and on moving from one type of land to another it would sometimes be necessary to substitute the cutting extensions on the rims of the buckets by picks, or *vice versâ*.

Costs.—The total expenses incurred in connection with the drainer during the trial may be summarised thus:—

	£	s.	d.
Fuel:—122 gal.	22	14	8
Cartage of fuel to drainer in the field (1 man + 1 horse for 2 days at 16s.)	1	12	0
Lubricants:—			
Oil (22¼ gal. at 8s. 2d.)	9	1	9
Grease (7 lb. at 1s.)		7	0
	£33	15	5
Wages:—			
1 man and 1 boy (2¾ weeks at £7 10s.)	£20	0	0

To the above must be added capital charges. The machine would probably not be running continuously throughout the year; assuming that it is used for only 6 months each year, an estimate of the capital charges may be made by charging interest at 7 per cent. and depreciation at 15 per cent. The total cost of the machine, with spares, including freightage to Scotland, was £1,414. Thus the annual charges are:—

	£	s.	d.
Interest at 7 per cent. on £1,414	98	19	6
Depreciation at 15 per cent. on £1,414	212	2	0
	£311	1	6

that is, the cost per week, assuming 26 running weeks per year, is £11 19s. 4d., and the cost for the duration of the trial, 2⅔ weeks, was £31 18s. 3d. For repairs and maintenance the machine cost £10 3s. 9d. during the trial, of which £1 5s. 0d. was expended on a tile-mould and can fairly be deducted as a permanent improvement. This leaves repairs at £8 18s. 9d.

The summary below shows in the first column of figures the actual costs of the machine for the full period of 2⅔ weeks, from the time it entered the first field until the digging operations ceased on September 7th. The second column gives a calculation of the costs of operating the machine for

TABLE IV.

	For the trial.	Per running hour, actual.	Per running hour, under commercial conditions.
	£ s. d.	£ s. d.	£ s. d.
Fuel, lubricants, &c. ...	33 15 5	12 9	12 0
Wages	20 0 0	7 6½	4 10
Interest and Depreciation	31 18 3	12 0½	5 8
Repairs	8 18 9	3 4	3 4
	£94 12 5	£1 15 8	£1 5 10

each running hour of the 53 hours during which the machine was actually digging. Referring now to Table III, which gives the chains of trench actually excavated per running hour under various conditions, we are enabled easily to calculate the cost of excavating such trenches; thus:—

3 ft. 6 in. trenches in moist stiff clay, where 1·7 chains were excavated per hour, cost 20s. 11d. per chain.
2 ft. 6 in. trenches in similar clay, cost 10s. 2d. per chain.
3 ft. 6 in. trenches in dry clay „ 11s. 11d. per chain.
2 ft. 9 in. trenches in dry clay „ 7s. 9d. per chain.
2 ft. trenches in dry clay „ 4s. 0d. per chain.

It has previously been indicated that, from the nature of the case, the organisation of labour left something to be desired; there were none of the usual incentives to speedy work which play so important a part in successful commercial organisation, and consequently the hours actually spent in digging, approximately only 3⅓ per day, are capable of being greatly augmented, both by a longer working day and by speeding-up repairs. A working day of, say, 10 hours, during 7 hours of which the machine is actually digging, should be possible. If this were done, the expenses under certain of the headings would be reduced greatly, and it is interesting to examine how these might be effected. The first item, fuel, lubricants, &c., would not be affected much, because fuel consumption is roughly proportional to work done; none the less, short running hours inevitably lead to uneconomical consumption of fuel and some economy would result, possibly 12s. per hour instead of 12s. 9d., from longer running hours.

The men were paid for a nominal working day of 8 hours, which, in fact, was rarely attained. If they were working a 10-hour instead of an 8-hour day, and were paid time-and-a half for the extra time, the cost for the period would have been increased from £20 to £27 10s., but assuming the drainer to have been running 7 hours each day, the cost per

hour for wages would have been reduced from 7s. 6½d. to 4s. 10d. Interest and depreciation would have remained constant for the period, but the cost per running hour on this head would have been reduced to 5s. 8d. Repairs may be expected to remain the same per running hour as in the actual experiment.

The last column in Table IV gives a sum of these estimates equal to £1 5s. 10d. per running hour, and referring again to Table III for the work done per running hour we obtain the costs per chain in each case as follows:—

	s.	d.
3 ft. 6 in. drains in moist clay	15	2
2 ft. 6 in. drains in moist clay	7	4
3 ft. 6 in. drains in dry clay	8	7
2 ft. 9 in. drains in dry clay	5	7
2 ft. drains in dry clay	2	10

The fact which is brought out most strikingly by a consideration of these figures is that the costs of digging in a dry subsoil are much reduced. Since the machine was not used on wet clay, it is impossible to say whether the cost of digging in wet clay would be greater or less than in moist clay, but the figures suggest that the best financial results will be obtained in summer use.

The next point to note is that the cost of shallow drains is very much less than that of deep ones; thus 3 ft. 6 in. drains in dry clay cost exactly three times as much to dig as 2 ft. drains in similar soil. So pronounced a result was contrary to original anticipations.

Comparing the cost of digging trenches with the "Buckeye" with that by hand is not an easy matter unless the work be carried on side by side. At the demonstration the cost of excavating the 3 ft. 6 in. mains which, under commercial conditions, we have shown might be 15s. 2d. per chain in moist clay and 8s. 7d. in dry clay, was estimated by practical farmers who saw the work to be between 12s. and 17s. per chain if dug by hand at present prices. The cost of digging 2 ft. 6 in. drains in clay at the present time would probably approximate 6s. per chain, which may be compared with 7s. 4d., the estimated cost per chain for 2 ft. 6 in. drains in moist clay and with 5s. 7d. the cost per chain for 2 ft. 6 in. drains in dry clay. Similarly, the cost of 2 ft. drains in clay if dug by hand would probably cost now about 4s. per chain as compared with 2s. 10d. by the "Buckeye" in dry clay. It is to be noted further that, provided the man who controls

the drainer is reasonably careful, the work of " bottoming " before laying the tiles is negligible, so that further economy may result here. On the other hand, if the operator is careless, the cost of " bottoming " as compared with hand digging, may be excessive.

One other advantage is to be claimed for the " Buckeye " Drainer, namely, speed of work. The rate at which draining can be done by hand is phenomenally slow. A man can scarcely excavate 2 chains of 2 ft. 6 in. trench in a day of 8 hours, while the " Buckeye " can do it in dry clay in about 20 minutes. Lastly, hand draining is very heavy work which few labourers relish.

Further Developments.—The trial showed that the friction produced by the revolution of the digging wheel in moist clay greatly retarded the speed of work and raised the cost. This friction was chiefly between the outside rims of the wheel, to which the clay adhered, and the sides of the trench; it was necessary frequently to stop and attempt to clear the rims. If scrapers could be fixed to the framework and adjusted to remove the adhering clay from the sides of the wheel, much of the friction would be obviated and increased economy of working obtained.

The digging wheel is designed to be fitted with digging buckets of two sizes; the small size excavates a trench $11\frac{1}{2}$ in. wide and the large size one of $14\frac{1}{2}$ in. In the trials at Croxton the small-sized buckets were used throughout for both mains and minor drains. For main drains, if men must work in them to adjust grades in cases of error in digging, $11\frac{1}{2}$ in. is the smallest practicable size, but for shallow drains 11 in. is extravagant. If the digging wheel were smaller, so as to dig a maximum drain of 11 in. and a minor of 8 in., considerable economy of fuel might be expected, and, consequently, greater speed of work.

Not only is the " Buckeye " suitable for displacing hand labour in digging drains for " thorough " draining, but it is also suitable for digging the mains in co-operation with the mole plough, especially on land with a slight fall or irregular surface, where frequent mains are essential.

The success of the " Buckeye " at Croxton warrants a more extensive use of the implement under commercial conditions, but the capital involved is too great to justify its purchase by farmers unless they are farming on a very extensive scale. It is an implement which may well be purchased by a land-

owner having a large area of land needing drainage, or by an agricultural engineer in a similar district who would contract to drain land by the use of the "Buckeye" just as he now contracts to drain with the mole-plough.

Conclusions.—1. The "Buckeye" Drainer proved itself capable of excavating straight trenches for land drainage to any depth not exceeding 4 ft. 6 in.

2. It was not successful in excavating trenches with a curve approximating to a right angle—which is sometimes necessary where the main has to be led to its outfall; under such conditions, it is better to build a catchpit at the angle of the bend.

3. Trenches were excavated at varying speeds according to depth and moisture of subsoil; 3 ft. 6 in. drains in moist clay were dug at the rate of 1.7 chains per running hour, and in dry clay at 3.0 chains per hour; 2 ft. drains in dry clay at 9 chains per hour.

4. In the experiment the costs of working were high, because of the conditions under which labour was employed. An attempt has been made on a conservative basis to estimate the costs of operating under commercial conditions, and they compare favourably with present costs of hand digging.

5. If the "Buckeye" Drainer were fitted with a wheel and buckets capable of digging trenches 11 in. as a maximum and 8 in. as a minimum, instead of 14½ in. maximum and 11½ in. minimum, considerable economy in costs of operating might be expected.

6. The implement is not suitable for farmers to purchase unless operating on a very large scale; it is suitable for use by agricultural contractors or by landowners with large estates needing drainage.

In conclusion, my thanks are due to Mr. Arthur Amos, M.A., of the School of Agriculture, Cambridge, for planning the observations recorded here and assisting with the report; to Mr. Thompson Close, the Ministry's Inspector, for valuable help with the more technical details of the trial; to Mr. L. F. Newman, M.A., of the School of Agriculture, Cambridge, for kindly undertaking the analyses; and to Sir Douglas Newton and his staff for facilitating the observations.

GRADING AND PACKING OF FRUIT.

H. V. TAYLOR, A.R.C.S., B.Sc., M.B.E.,
Deputy Controller of Horticulture.

AT present very few people interested in the fruit industry would deny that those trading in fruit have a grievance. The fruit sent to them by growers might be packed in a far better manner, but before any improvements can be made it becomes necessary for the grower to realise this point, to select good sound fruit of various sizes and quality, and to pack it in a suitable package, in order that it may be distributed through the trade to the consumer with the least possible loss of freshness. No doubt many growers in the past have done this, but since the wholesaler and the retailer have not recognised these sound and honest packages of fruit, the cash returned to the grower has not repaid him for the extra labour which he has employed. To guard against this it may be an essential part of the scheme for the grower to use a label on which may be described the weight, variety, quality and grade of the fruit. In some measure the label becomes a form of contract between the grower and the retailer. So that these guaranteed packages of fruit can be easily recognised amongst the ordinarily marketed packages, the label should be somewhat conspicuous in design. In all probability even this would be insufficient, for though any grower in this country might pack fruit in a perfectly honest manner, and use a label of his own, it would take a very considerable time for him to establish the worth of such a personal label, in our complicated marketing system. Experience in marketing in this country, chiefly in connection with produce from the glass house industry, has shown that it is possible for even an individual grower's trade-mark to be of considerable value, though no doubt the time for this to become established has been considerable. Time is an important factor, and if large numbers of growers are to give up their old methods of packing and marketing fruit for a newer system, which will involve more labour, additional expense and detailed supervision, they must be assured of an immediate increased return. It may therefore be necessary for the label to be guaranteed by some official body, such as a Growers' Federation of some considerable importance, or even by a Department of the Government. In other countries the label has been guaranteed, sometimes by a Government Department (as in South Africa and California), and sometimes

by a Growers' Association, with a certain measure of assistance from Government Departments—a practice which has proved successful in Canada.

A review of the Canadian and American literature on this subject will show that in the majority of instances the growers' organisations started all these measures of reform on a voluntary basis, but before an extension of the scheme was possible it was necessary to secure Government assistance with legislation. There is a genuine desire to avoid legislation here if the reform measures can be established on a voluntary basis. The legislation in other countries was generally in the direction of defining standards for certain grades and classes of fruit, though in some cases it definitely decided the weight of goods to be sold in each package, and the size of the package which was to contain the fruit. In a few instances also, legislation provided that all the fruit was to be labelled and ascribed to its proper class.

The question has rightly been asked in America: "What is the object of legislation, laying down standards for produce of this nature?" and the answer has been that standardisation, in establishing a guide to the measure of quantity, weight, extent and value, sets up a standard for a given commodity, and classifies other commodities by comparison with the given standard. Such a standard will stabilise the business by providing a common ground whereon the buyer can meet the seller with the assurance that each is talking in the same understandable language. Most of the grievances of trade are due to the lack of this common language.

The various sections of the horticultural industry have recently considered this matter very carefully among themselves and in consultation with Government Departments. They have in fact considered a scheme put forward by the Ministry for dealing with this problem. There is undoubtedly a genuine desire among the best growers of this country to regard the defects as the business of the growers, and they propose to deal with this matter with a definite scheme of their own through the Growers' Associations, and to seek no aid from the Government, other than advice and some little assistance in the initial stages. The desire of the growers to put their own business in order is a right one, and a very welcome one, and it is the hope of the retailer and the wholesaler that the scheme will succeed. The scheme of the Ministry will remain in abeyance, but the plans are at the disposal of the Growers'

Association for their use if they decide to accept them. If this growers' scheme should fail, it is recognised that probably the next step of reform to be asked for by the retailers would be legislation, which in itself would mean some measure of control of the industry, a matter which neither Government Departments nor growers would welcome.

Growers' Scheme.—It would be necessary for the Association of Growers, having decided to adopt a scheme, to have a large supply of labels printed and distributed throughout the country by some organisation to individual growers, from whom it would be necessary to obtain guarantees that the labels would be properly used and in accordance with the conditions imposed. In theory it does not appear necessary for the packing of the growers to be carefully inspected before the packages are sent to the market, as the salesmen and retailers would soon discover any discrepancies. The conditions attaching to the use of the label would need the most careful consideration, but on the following points most people are agreed :—

(1) That the Growers' Association's name should appear on the label.

(2) That the label should only be used for certain agreed varieties of fruit, and the name should be stated on the label.

(3) That the grower before despatching the package should state on the label the number or name by which he is known to his Growers' Association, the class, quality or grade of fruit within the package, and the net weight or count of the fruit.

These are essential points that the salesman and the retailer can reasonably ask to know, and should be regarded as indispensable. Provided that the label is only used in a proper manner, no complaints would be received, a state of affairs not likely to exist for long. Some people through carelessness, and others through ignorance, might possibly use the label for packages for which labels were not intended, and complaints would arise. To trace the events as they are likely to occur it may be assumed that those receiving packages of fruit bearing these guaranteed labels, the contents of which do not comply with the description on the label as to weight, variety, grade or quality, would undoubtedly seek satisfaction from the sellers of the goods, and in many cases adjustments would be made. In cases of failure the matter would, no doubt, be reported to the Growers' Association named on the label, and it would be necessary for the Association to make such investigations as are necessary, and attempt to effect a settlement. If unsuccessful, the matter can only be dealt with by arbitration, and perhaps this is the most difficult part of the scheme to

work, for it may be necessary in most of the large marketing centres to set up tribunals of arbitration, the constitution of which would include representatives of the Growers', Wholesalers' and Retailers' Associations. These tribunals would act in their respective markets, and give decisions as to the classification of packages of fruit wrongly described. Settlement on the decisions would follow. An essential part of a scheme must give due consideration to finance; nor is it shown to what extent the Growers' Association are financially responsible for the packing of fruit bearing their authorised labels.*

A scheme of this nature instituted solely by the growers can only succeed if it has the support of the wholesaler and the retailer, and in the past they have turned all the blame for the present unsatisfactory marketing on to the shoulders of the grower. There are many ways in which the salesmen can render assistance. It has been stated that many growers have in the past adopted proper methods of grading and packing, but the market returns did not show any extra value for the goods, and as they had previously expended money in extra labour charges they discontinued the practice. It is now the duty of salesmen to look out for labelled packages, and in selling them to see that some extra price is obtained for the extra attention given. It should be their duty to co-operate with the growers and the Growers' Association in working the scheme and to facilitate the settling of complaints. At present each small consignment has to be dealt with separately by a salesman, much waste of time is caused in the markets, and his charges for labour are heavy. Under the new scheme, if he is dealing with standard packages, the consignments may be bulked together, and sold as per sample. This will lead to reduced space and labour costs, a portion of which may be reflected in the charges returned to the grower. The salesman and the retailer can co-operate to encourage the more extended use of fruit, especially home-grown fruit.

Before this scheme can be launched and put into practice it would be necessary for decisions to be made in many matters of detail—some trivial and some important. None, however, will be more difficult or more controversial than the question of the "package." Those in use to-day have been selected either because of cheapness, usefulness for preserving the freshness of fruit, or ease in handling.

A grower in this country supplying goods direct to the retail shops naturally finds it most convenient to use a package which

*All these are details which can be settled after further experience has been gained.

can easily be filled and easily emptied, provided it is of sufficient strength to protect the goods during the short journey in the carts. For this class of carrier it is almost immaterial whether it is a box, barrel, basket, or even a tray. Growers situated at considerable distances from the shops, who are thereby compelled to send their goods by rail to the markets, would select packages strong enough to stand a long journey, easy to handle, and light when empty, and this is probably the reason why baskets in preference to boxes have been chosen. Growers situated in other countries wishing to send their fruit to this country have other factors to consider, the two most important of which are, that the fruit has to be packed and held firm by the package to permit of no jolting during the journey, and the package has to be of such size and shape that when large numbers are stored in the ship's hold there is the minimum loss in space. A rectangular wooden box of some strength was suitable for this purpose—which is probably the explanation of its selection.

This does not necessarily mean, or in any way prove, that the wooden box is superior to the basket, but only that it is superior for shipment. Insomuch, however, that before boxes can be properly packed with fruit the produce must have undergone a most careful grading, and therefore in bulk presents a good appearance when purchased, they have become popular in the English markets, and it is not unlikely that British fruit growers may have to consider this feature, and to select the box as the future package for some of the best varieties of fruit. Financial consideration, of course, must be very carefully considered; the box is an expensive package and it may be only possible to use it for expensive varieties of dessert apples. Whether the price realised for culinary varieties, except for the choice samples, would allow growers to use boxes is a matter for further consideration. Future experience alone will decide, but so far as can be seen at present, larger wooden packages, such as half-barrels, would appear to be the more economical package.

In conclusion it has been proved that the present methods of growing and marketing fruit, if persisted in will leave an easy field in the British markets for imported apples. It should be the immediate duty of all persons engaged in the industry to co-operate to put this matter on a sound business basis, so that the grower, the wholesaler, the retailer, and the consumer will all be satisfied with British grown fruit.

RESEARCH IN ANIMAL BREEDING.

IV.

R. C. PUNNETT, F.R.S.,
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In the previous articles of this series, published in the April and May issues of the JOURNAL, *Professor Punnett dealt with the coat colours in cattle and the crossing of polled with horned cattle as illustrations of simple Mendelian inheritance. In the June issue of the* JOURNAL *a description was given of the experiments undertaken with poultry and rabbits which were designed to investigate the inheritance of weight and coat patterns.*

ONE of the most striking points of difference between the higher animals and plants is that in the former the sexes are separate, while the latter are most often hermaphrodite. Associated with the bisexual mode of reproduction are peculiar features of heredity which have formed the subject of active investigation in recent years. As the result of much work in different parts of the world, the tangle of sex and its dependent characters is gradually being unravelled. In the first place we recognise sex itself as being inherited on Mendelian lines. Speaking generally, one of the features of sex-heredity is that the two sexes are produced in equal numbers. Male and female give males and females in like proportion, and it will be remembered (p. 15) that recessive and impure dominant give recessives and impure dominants in like proportion. Hence the conception that one sex is recessive and the other an impure dominant. The pure dominant can never arise, for male cannot be fertilised by male, nor female by female. Then comes the question, which sex is to be regarded as recessive, and which the impure dominant—which is the sex that produces germ-cells all of the same sex, and which the one that produces equal numbers of two kinds of germ-cells differing in their sex-determining properties? Experience has shown that there is no general rule for all animals. In man the male produces two kinds of sperms, but in the case of poultry it is the hen that produces two kinds of eggs; on the other hand women and cocks agree in that each produces only one kind of germ-cell in respect of sex-determination. In man the two kinds of sperm decide the sex of the child; in the fowl the two kinds of egg determine whether there shall hatch out a cockerel chick or a pullet.

Earlier experiments, conducted in Cambridge, had revealed the existence of a peculiar form of inheritance to which the name sex-linked heredity was given. The nature of this may be illustrated by a case of the sort which was investigated on the University Farm. In discussing the Hamburgh-Sebright cross used for the weight experiments we stated that the Hamburgh was a gold pencilled, and the Sebright a silver. These colours were deliberately chosen as there was some evidence that gold and silver formed an alternative pair, and that the case was one of sex-linked heredity. The experimental work showed that this was so. Silver behaves as a simple dominant to gold, but in the hen the transmission of the factor for silver is sex-linked. The silver hen, no matter how bred, is never pure for the silver factor; half of her eggs are "silver" and half are "gold." Moreover she transmits the silver factor to her male-producing eggs, and the gold to her female-producing ones. If we denote silver by *S*, and gold by *s*, and maleness and femaleness by *M* and *F* respectively, then the constitution of the silver hen is *MFSs*. Such a hen forms two kinds of eggs only, viz., those bearing maleness and silver (*MS*), and those bearing femaleness and gold (*Fs*); and they are formed in equal numbers. This is at once apparent when she is mated with a gold male, *MMss*. All of the sperms of such a cockerel are of the same kind in respect of these factors, viz., *Ms*. The male eggs of the silver hen (*MS*), when fertilised by the sperm of the gold cockerel (*Ms*) give birds of the constitution *MMSs*, *i.e.*, silver males. The female eggs of the silver hen (*Fs*) when similarly fertilised, give birds of the constitution *MFss*, *i.e.*, gold females. We have bred a great number of birds from the mating of silver hen and gold cockerel, and have never met an exception to the rule that the cockerels all come silver, and the pullets all gold.

This peculiar sex-linked type of inheritance is found in several other characters in poultry. It was demonstrated in America to hold good for the character of barred plumage such as is found in Plymouth Rocks. Barring is dominant to self black, but the barred hen is never pure for the barred factor. She transmits barring to her sons and black to her daughters. When mated with a black cockerel she gives only barred cockerels and black pullets. This observation we have been able to confirm in the course of our experiments.

As has already been pointed out in this *Journal*,* sex-linked

* The Early Elimination of Surplus Cockerels, by R. C. Punnett. *Jour. of the Bd. of Agric.*, February, 1919, p. 1319.

inheritance may prove to be of economic importance for the poultry breeder. Golds and silvers can be distinguished in the downs of the newly hatched chicks. By mating hens belonging to the silver class with cockerels belonging to the gold class, it is possible to tell the sexes apart *with certainty* immediately they hatch, and this is also true when barred hens are mated with black cockerels. By making use of suitable crosses the breeder of poultry for egg production can be sure of rearing nothing but pullets through the earlier and more costly stages. If the method were more generally followed, the poultry population of these islands would consist of a far higher proportion of the more valuable hen, and a markedly higher total production of eggs for the same expenditure of food and labour.

During the course of our work we have kept a number of pure breeds, and we have also made many crosses between them. A point that has impressed us greatly is the superiority of the first-cross birds as compared with the pure breeds. Under the same conditions the hatching power has been distinctly better, the chicks have been stronger, and mortality among them has been markedly less than for the pure-breed birds. The results have often been so striking that we feel it would be to the interest of utility poultry breeders if more extended trials could be undertaken. Carefully devised experiments of this kind might also be expected to throw light upon some of the vexed problems associated with inbreeding and crossbreeding.

Our investigations into sex-linked heredity have served to confirm and extend the earlier work at Cambridge, where the phenomenon was first discovered; and we should state that even ampler confirmation has been provided by other workers, notably in the United States. It is a phenomenon of great importance to the breeder, for it undoubtedly plays a large part in the heredity of animals with bisexual reproduction. Moreover the understanding of it may prove to be of high economic value. Professor Pearl in America has published an account of some experiments which suggest that high fecundity in poultry is transmitted on these lines. The highest grade of laying hen owes this quality to the possession of a definite laying factor. But she is never pure for this factor, and, as it is sex-linked in heredity, she transmits it only to her sons. The high-grade layers therefore must get this factor from their father, and the high prices paid to-day for the sons of hens with a high egg record is evidence that the enlightened breeder is already taking advantage of Pearl's experimental work. There

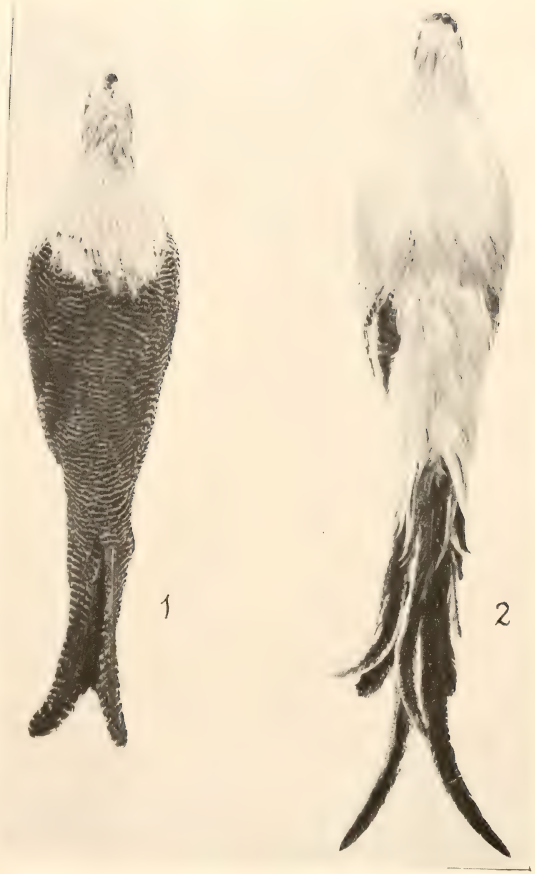

PLATE 1.—Skins of two silver-pencilled Hamburgh cocks, bred from the same hen. Fig. 1 is the skin of a henny cock, and Fig. 2 the skin of a normal-plumaged cock.

PLATE 2.—Fig. 1, skin of a henny cock. Fig. 2, skin of a castrated henny cock, which moulted into normal plumage after the operation. Before the operation the bird was very similar to the one shown in Fig. 1.

is evidence too that some factor leading to increased milk yield in cattle is transmitted on the same lines. Here, however, sex-linked transmission is by the bull, not by the cow. For cattle, like men, are mammals, and it is probably the male in mammals that produces two kinds of sperm differing in their sex-determining properties, while the female produces only one kind of ovum. The bull may transmit something to his daughters that he does not transmit to his sons.

The Cambridge work has also included another series of experiments dealing with a character of which the transmission is closely wrapped up with that of sex. In certain breeds of poultry the cock is feathered like the hen. He lacks the long hackles of the neck and saddle, and the curved tail sickles of the normal male, their places being taken by feathers such as are normally found in hens. This feature of henny feathering in the cockerel is found in Sebright Bantams, Campines, Henry Game, and occasionally also in other breeds such as the Hamburghs (see Plate 1, Fig. 1). In our experiments the character was introduced by means of the Sebright Bantam. We found that henny feathering was dependent upon a definite factor, and that henny feathering in the cock is dominant to normal feathering. In its first plumage the henny cock may be intermediate between henny and normal feathering, but when this is the case he takes on the henny plumage at his first moult. Either sex in henny breeds can transmit the henny factor. From a bird of a pure henny breed, whether cock or hen, crossed with a bird of a normal breed, all the cocks produced are henny. The hens, however, are like normal hens in appearance, nor is it possible to distinguish hens which transmit henny feathering to their sons from those that do not. The interesting point then arises as to how we are to regard normal breeds where the hens are hen-feathered and the cocks are cock-feathered. A marked step towards the solution of this problem was made by Pézard in France, and Goodale in America. Both these observers found that complete removal of the ovary, a very difficult operation, led to the castrated hen assuming cock-like plumage at the moult. The obvious inference is that the normal hen is potentially cock-plumaged, but that she forms a substance in the ovary which circulates in the blood, inhibiting the development of cock plumage, and rendering her henny. Further, since we can attribute henny feathering in the cock to a definite factor, we are led to suppose that the hen of normal breeds also carries this factor, though she transmits it only to her daughters, and

they again only to their daughters. Interesting support of this view is derived from the results of castrating henny cocks. It is well known that castration of normal cocks has no marked effect, and that the plumage of the capon is similar to that of the uncastrated bird. Castration of the henny cock, however, results in the bird assuming the normal cock plumage at the moult. This was first demonstrated by Morgan and Goodale in America, and has since been confirmed by Dr. F. H. A. Marshall in Cambridge. Plate 2 shows the skins of a henny cock, and of a castrated henny cock which, after moulting, assumed the plumage of a normal Brown Leghorn. Before castration this bird closely resembled the henny cock shown in Plate 2, Fig. 1.

We must suppose that in the henny cock, as in the hen, the henny type of feathering is due to some substance circulating in the blood, inhibiting the production of normal male feathering. Moreover, this substance must be produced by the genital gland in the henny cock as in the hen. It may be produced by a testis as well as by an ovary. The hen is not hen-feathered in virtue of her femaleness, but because she has received from her mother a definite factor which she transmits only to her daughters in the sex-linked way. At some time or other in the history of the fowl this factor went, as it were, astray, and entered into a male-producing egg; though how this came about we do not at present know. When, however, the dislocation happened it became possible to take advantage of it, and to build it up as a breed character. It is well known that the henny Sebright Bantams owe this peculiarity to a casual henny bantam cock that Sir John Sebright noticed about a century ago. Whatever may be the economic outcome, it is evident that the analysis of such cases as that of the henny cock is giving us a clearer insight into the problem of secondary sexual characters, which can never be neglected by the breeder.*

A few words may be said of some experiments undertaken in order to investigate the characters of egg-colour and broodiness in poultry.† That we were unable to work out these characters in the way that we desired is due to circumstances brought about by the War. When they were planned there was a fair prospect of funds being found for the extension of the

* A full account of this case will be found in the following paper:—Genetic Studies in Poultry. III. Hen-feathered cocks, by R. C. Punnett and the late P. G. Bailey. *Journal of Genetics*, XI, 1921.

† Genetic Studies in Poultry. II. Inheritance of Egg-colour and Broodiness, by R. C. Punnett and the late P. G. Bailey. *Journal of Genetics*, X, 1920.

work necessary to complete it. War difficulties, however, forced us eventually to abandon the work before it was finished, and since the Armistice the funds available for this kind of research have not been sufficient to justify us in undertaking fresh experiments on these lines. Such results as we managed to obtain are not without interest, especially in view of the economic importance of the characters investigated. We began in the usual way, crossing birds of a brown-egg broody strain with birds of a white-egg non-broody strain. For the former we selected the Black Langshan, and for the latter the Brown Leghorn and the Gold Pencilled Hamburgh. In respect of egg-colour the first-cross hens were intermediate, though the tinted eggs they laid approximated more to the lighter than the darker kind of the parental breeds. In the F2 generation nearly 120 birds were tested, and great variation was found. Some laid white eggs, a few laid dark eggs resembling those of the Langshan, while the great majority laid tinted eggs. The grades of tint varied from nearly white up to full brown. For a given hen the grade was fairly constant, though it varied somewhat with the season, especially in the case of those birds laying the more deeply tinted eggs.

In its broad outlines the case was not unlike the weight case in poultry; viz., an intermediate F1 generation of fair uniformity, and an F2 generation showing a full range of variation, between and including the two parental forms (Fig. 6, p. 254). It is probable that here also we are dealing with several factors, each of which influences the tint of the egg; and our experiments have shown further that such factors are transmitted by the cock as well as by the hen. There is evidence also of the existence of a factor which inhibits pigmentation of the shell, and this factor would appear to be linked with the factor for black down. F1 birds from the Langshan and Brown Leghorn cross all have the dominant black down of the Langshan. In F2 the brown-striped down of the Leghorn reappears in a quarter of the chicks. Our testing results showed that the layers of white and nearly white eggs were relatively much more numerous among the pullets that hatch black in down than among those that hatched brown. This peculiar linking of characters, though familiar to plant breeders, has not often been met with among the higher animals. Probably this is because relatively little work has yet been done with birds and mammals. It is likely that, as our knowledge increases, these cases of linkage between characters will become more plentiful and it is not improbable

FIG. 8.—Illustrating the distribution of Egg Colour among the Pullets of an F2 generation of Langshan × Hamburgh. The numbers indicate the grades of tint from White (1) to Brown (11).

that some of them may turn out to have an economic value. For if a visible character, such as colour or pattern, were linked with such a character as higher milk yield, or more succulent mutton, breeding for these latter characters would be greatly facilitated.

Of our investigations into broodiness we can say little more than that they have shown the character to be a complex one. Hens vary greatly in this respect. Some go fully broody each year; others go broody occasionally and for a few days only; and all intermediate grades exist. Nevertheless our experience affords grounds for supposing that the character can be analysed and expressed in terms of definite factors, though it is clear that the experimental work demanded would be both long and tedious. For in broodiness, as in egg-colour, the case is complicated by the circumstances that the factors are carried and transmitted by the cock, though he neither goes broody nor lays eggs. And the cock can only be analysed by mating him with hens of known constitution, and testing the nature of his female progeny—which takes time.

Incidentally our experiments elicited a fact of some interest to poultry keepers. It is well known that the typically non-broody races lay white eggs, while the races that lay brown eggs belong to the broody section. It has been held that broodiness is necessarily correlated with the brown egg, and that it is not possible to establish a non-broody brown-egg race. Our experiments do not bear this out. It is true that the brown egg may be correlated with broodiness: nevertheless, the linkage between the factors concerned, if it exists, is not complete, for we succeeded in combining the full brown egg with the non-broody character. We do not doubt therefore that, by working on the right lines, a non-broody race laying brown eggs could be established.

As a by-product of the above investigation we obtained data on the inheritance of leg-feathering. For the Langshan is a breed with feathered legs, while the Leghorns and the Hamburghs are clean shanked. Our own data, taken in conjunction with those collected by other observers, have served to show that at any rate two factors are concerned in connection with this character. As with weight and egg-colour, the factors produce a cumulative effect, and a continuous series is to be found ranging from excessive development in birds pure for both factors, to absence of leg-feathering where neither factor is present. For a detailed discussion, however, the reader may be

referred to the original paper.* We have mentioned the case because it affords another example of what, at first sight, appears to be blended inheritance, though here again, as in the cases previously described, analysis has shown that the apparent blending is probably due to the cumulative effect of several definite factors.

Lastly, we may mention that in the course of our work we have gathered much information that is likely to prove of value for specific purposes. Our experiments with rabbits, for example, though designed primarily to study the inheritance of weight and certain patterns, have been used, as far as possible, to analyse the factors upon which the colour of the coat depends. In connection with the establishment of the natural rabbit fur industry, which is beginning to make progress, the information has already been of service to the utility breeder; nor can it be doubted that, as our knowledge extends, it will prove of greater value in the future.

But after all the main object of the Cambridge work is the elucidation of the principles that underlie the phenomena of heredity. Once these have been revealed by research the application can be left to those who will derive profit from it. Of one thing, however, we feel sure, and that is that the breeder who masters the conceptions implied in the factorial theory of heredity will not only find in them a sure guide to practice, but will derive greater pleasure in the exercise of his craft as he sees fact after fact relating themselves to one another, and falling into place in a definite and orderly scheme.

(Concluded.)

* Genetic Studies in Poultry. I. Inheritance of Leg-feathering, by R. C. Punnett and the late P. G. Bailey. *Journal of Genetics*, VII, 1918.

MOSAIC DISEASE OF POTATOES.

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ALTHOUGH the disorder of potatoes termed Mosaic has only recently been regarded as a specific disease, there is evidence that it has been in existence for many years. At the present time it is found in potato crops all over Europe and in North America; and since the disease is distributed by means of the seed tubers it probably occurs wherever the potato is grown. Potato Mosaic has, up to the present, been studied more thoroughly in the United States than elsewhere, and the scientific information available is almost entirely derived from investigations carried out in that country.

Potato Mosaic in Britain.—Owing to the fact that Mosaic symptoms have not hitherto been regarded as those of an actual disease, it is not surprising to find that no general or popular name for the disorder exists. It is clear, however, that the terms " miffy " and " miffiness " in common use in certain districts are usually, if not always, applied to potato plants affected with Mosaic, and that Mosaic symptoms are more or less known to observant growers. There are Scottish growers who can recollect having observed the characteristic mottling of Mosaic for forty years, and in all probability the disease has been general in Britain for a much longer period. It is also clear that what is spoken of in the south of England as " deterioration " in potatoes is at times only the result of a general attack of Mosaic disease.

The disease occurs in all parts of the British Isles, though in varying intensity, and is frequently responsible for light crops on farms, and, to an even greater extent, in gardens and allotments. For this reason growers are advised to make themselves acquainted with the appearance of Mosaic and with the extremely important discoveries with regard to its contagious nature (see p. 338), since remedial measures can only be adopted after the disease has become fully recognised and the facts as to its method of spread appreciated.

Mosaic Diseases in General.—Before describing the symptoms of Potato Mosaic it may be advisable to record what is known of Mosaic diseases in general. They constitute a group or class of diseases of an infectious nature, this being proved by the fact that if the sap of a diseased plant is inocu-

lated into a healthy one the disease is reproduced either immediately or in the progeny of the inoculated plant. The causal agent is not known, but it has been shown that fungi are responsible and bacteria have not been found. It is clear, however, that the infective principle or virus is present in the cell-sap, but the nature of this virus has so far eluded the search of the highest powers of the microscope. Whatever the infective principle may be it is in some cases so potent that even the most minute quantities of infected sap conveyed by small sucking insects such as aphides are sufficient to transmit the disease. Among other important crops in which infectious Mosaic disease occurs are those of tomatoes, beans, cucumbers, sugar-beet, maize, sugar-cane and tobacco.

In some cases (*e.g.*, dwarf beans) Mosaic is transmitted from season to season through the seed, but in others (*e.g.*, tobacco) this does not appear to be the case. In Potato Mosaic it is carried by means of the tubers, and thus, like Potato Leaf Curl, it may, in a loose sense, be said to be inherited.

Description of Potato Mosaic.—The symptoms of the disease vary somewhat, both in different varieties and in different parts of the country, but the following account will probably suffice to indicate the features by which Mosaic may be recognised.

The most obvious and distinctive character, and the one from which the disease takes its name, is the mottling of the foliage. The individual leaflets, instead of presenting a normal, uniformly green appearance, are faintly mottled or mosaicked in varying shades of green.* Usually coupled with the mottling is a crinkling of the foliage—a waviness in the outline of the leaflets and other indications that the leaves are not normal. In some varieties and in severe attacks this crinkling or puckering becomes very marked. Typical Potato Mosaic may nearly always be seen (in early summer especially) in the very susceptible varieties mentioned on page 339. Under certain conditions, and especially if it only develops late in the season, this mottling of the foliage may be very conspicuous, but the plants otherwise appear healthy and may produce a good or fairly good crop of tubers.

In more severe attacks other symptoms are apparent. A dwarfing tendency is very frequently manifested, and when

* It should be noted that this mottling is a very faint one and quite different from the bright yellow spots found not infrequently in certain early varieties. The latter is a variegation and not Mosaic or any form of disease.

this takes place there is a marked reduction in the yield. In extreme cases the growth of the plants may be completely stunted, and when this stage has been reached the crop is reduced to practically nil.

An important point to be noted in recognising the disease is that, though mottled foliage is one of the principal diagnostic characters and is usually very marked and conspicuous, this is not invariably the case. The mottling appears to be modified materially by climatic conditions. In cooler and damper regions, typically mottled foliage may be found throughout the entire season, but in the hotter and drier parts of the country this feature, though quite apparent earlier in the season, may become much less marked later and may even disappear entirely. The crinkling of the foliage, however, remains.* This is comparable with observations made in the drier States of America, where, though the yield is very much reduced, the mottling symptoms are completely suppressed. It has been proved experimentally that this is a climatic effect. Plants of the same stock of seed were planted in Maine and Colorado. Mottling occurred in Maine but none developed in Colorado. That the stock did not lose the disease but was still infected was shown by the fact that when the southern-grown crop was returned to its northern station, the mottling reappeared. It would also seem from certain experiments that, though typical mottling is more *conspicuous* in the north, the *effect* of the disease may be more serious in the hotter parts of the country.

Intensity of the Disease and Effect on Yield.—As will be gathered from the above description of symptoms, the intensity of the attack varies greatly. In general the effects of the Mosaic disease are more severely felt in the drier and warmer parts of the country, and, as indicated in the preceding paragraph, climatic conditions appear to be the main (though perhaps not the only) factors governing the degree of intensity exhibited. Owing to Mosaic disease having only recently been recognised in England, few precise records exist as to its effect on the yield. It is probable that in most parts of Scotland and in the cooler and damper parts of England and Wales the diminished yield due to the disease is relatively slight. In the warmer and drier parts of England, however,

* The mottling symptoms are more clearly seen on a dull day or when a shade is thrown over the plant. A white sheet of paper held under the leaf also assists in throwing the mottling into relief.

there is evidence that the reduction is more marked. Under average field conditions, affected plants appear to show a decrease of 15 to 35 per cent. in yield as compared with healthy plants. It is true that only a certain number of plants in the crop are attacked, but even at a moderate estimate the aggregate loss due to Mosaic in the midland, southern and eastern counties of England must be very considerable. In gardens and allotments where local or home-saved seed is used, a very dwarf form of the disease frequently occurs, and the losses are much more serious.

Mosaic is particularly troublesome to the potato breeder. In certain districts of England it persistently attacks seedlings in its most intense form, and may at times practically kill out first year plants.

Transmission of the Disease.—It has been clearly established that Potato Mosaic is carried from season to season in the seed tuber, and that diseased plants do not recover, their progeny reproducing the disease each successive year.* It is also known that Potato Mosaic is infectious, inasmuch as healthy plants, if surrounded by, or grown in proximity to, diseased ones, are liable to contract the disease and show it the following season in their progeny.

The method by which infection of healthy plants takes place in nature is recorded in two papers recently published in America.† It was discovered that, as in the case of Tobacco Mosaic, the disease virus was conveyed by Aphides ("green-fly") which fed on affected plants, the particular species responsible in the State of Maine being chiefly the Spinach Aphis (*Myzus persicæ*). Experiments proving this were carried out both in the greenhouse and in insect-proof cages in the open. If Aphides which had been sucking the juice of diseased plants were introduced into the cages, infection followed; if Aphides from healthy plants were introduced, no infection followed. Where infection took place early in the season, the mottling of the foliage developed during the same season, but when the plants were inoculated later, the disease

* As a rule the whole progeny of a newly-infected plant shows the disease the following season, but occasionally, perhaps in cases of late infection, a few tubers escape and give rise to healthy plants.

† Investigations on the Mosaic Disease of the Irish Potato, by E. S. Schultz, D. Folsom, F. M. Hildebrandt, and L. A. Hawkins. *Journ. Agr. Research* XVII, pp. 247-273, 1919.

Transmission of the Mosaic Disease of Irish Potatoes, by E. S. Schultz, and D. Folsom. Loc. cit., XIX, pp. 315-337, 1920.

only showed itself in the progeny the following year. On the negative side it may be noted that no infection followed when biting insects, such as Flea-beetles or Colorado Beetles, were used: neither was there any evidence that the disease was contracted from the soil.

Susceptibility of Varieties.—During 1920 the Ministry undertook a preliminary survey of the distribution and intensity of Potato Mosaic in England, and observations were also made on the relative susceptibility of the different varieties. It would be premature as yet to generalize from the information obtained, but the following may be taken as holding good. It was found that, though the disease occurred to a limited extent in almost all varieties, both early and main-crop, there was a very marked variation in the percentage of infection commonly present as well as in the intensity of the attack.

Under field conditions four varieties stood out above others as being specially susceptible. These were Golden Wonder, Langworthy, Burnhouse Beauty and Tinwald Perfection. In these varieties, affected plants to the extent of 30 per cent. and upwards of the crop were commonly found in all parts of the country, whilst in some fields 75 per cent. or even 100 per cent. showed the disease. It should be noted that the first two varieties mentioned, although of good quality, are well known to be particularly light croppers; and there can be little doubt that this peculiarity is due to the very general presence of Mosaic disease. Other varieties which showed the disease in some quantity were Arran Chief, The Ally, Dargill Early, and King Edward. It is obvious that these badly-infected stocks should, if possible, be eliminated and cleaner stocks worked up.

Measures of Control.—The two points to be clearly grasped are:—

(a) Infected plants do not recover, but carry the disease from season to season by means of the tubers. (b) By reason of aphis attacks the disease is transferred from infected plants to healthy ones and asserts itself more prominently the following season.

The following preventive methods should therefore be observed:—

(1) Seed tubers should not be saved from diseased plants, nor from plots or fields where the disease is present in any quantity;

(2) In the south, where the disease not only occurs in more severe form but is apparently more liable to spread (perhaps owing to earlier and more extensive attacks of aphides), extra care should be taken as to "seed." Where the disease occurs, no "seed" should be saved, but fresh "seed" should be obtained from a good district in the north of England or from Scotland or Ireland.

(3) Where Mosaic is persistently troublesome, varieties particularly subject to it should not be grown.

(4) Early rogueing is of some value, but under ordinary farm or garden conditions the amount of success obtained is not commensurate with the cost. In the case of new varieties or seedlings the matter is different and special methods are warranted. If rogueing is carried out with extreme care and thoroughness, and if aphis attacks are prevented by spraying with a good insecticide (such as nicotine and soft soap), complete success should be possible. In the case of valuable crosses, the use of aphis-proof cages might be considered.

(5) Those who grow for wholesale "seed" purposes should remember that, though the effect of Mosaic may be comparatively slight in the north, it is often more severe in the south, and as the disease becomes known the demand for Mosaic-free "seed" will increase. Disease-free stocks should be therefore retained and worked up for "seed" purposes. In the case of new varieties, it may pay to isolate these from other stocks, rogue carefully, and even spray with soft soap and nicotine in the summer months.

LIMING:

WITH SPECIAL REFERENCE TO THE USES OF GROUND LIMESTONE.

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"LIME, when laid on in large quantities, has in this country a wonderful effect. . . . From my own experience I know that no good crop can be expected under two hundred bushels of lime per acre. . . . Upon peaty ground at least double the quantity of lime may be used. Indeed, as I have before mentioned, you can scarce lay on too much upon such land."*

So wrote Thomas Johnes of Hafod, a distinguished Cardiganshire landlord, whose field expriments and various other investigations had a very marked beneficial influence upon the practice of farming in Mid-Wales at the commencement of the nineteenth century.

Down to the middle of last century farmers relied almost entirely upon lime and dung for maintaining and improving soil fertility. The latter half of the century, however, witnessed a great decline in the use of lime. This was due to several causes :—

(1) Extensive liming and under-manuring often resulted in soil exhaustion.

(2) The erroneous belief that the use of artificial manures did away with the need for liming.

(3) Shortage of farming capital due to the agricultural depression of the 'nineties.

(4) The increasing scarcity and cost of labour.

During the last 13 years the writer has analysed a large number of soil samples obtained from various districts in Mid and South Wales. The results of the analyses, considered in conjunction with field observations, appear to support strongly the substantial truth of Thomas Johnes's conclusions. The evidence in support of the view that the practice of liming in Mid and South Wales should become much more general may be briefly stated as follows :—

* "A Cardiganshire Landlord's Advice to his Tenants," by Thomas Johnes, Esquire, of Hafod, 1800.

(1) The great number of soil samples which the writer has analysed in connection with the advisory work of the Agricultural Department of the University College of Wales were, with very few exceptions, practically devoid of carbonates. Worse than this, a very high proportion of the samples were found to be distinctly sour.

(2) In practically every case where farmers, acting upon the recommendation given in the reports of these analyses, applied lime there followed a marked increase in crops.

(3) In several districts the "Finger and Toe" disease of the swede and turnip crop is very prevalent.

A striking example of this trouble is given by a farm in South Wales *situated within three miles of a limestone quarry and kiln.* This farm has suffered severe losses of crops due to the ravages of "Finger and Toe." The presence of an easily accessible source of lime in this particular instance brings out vividly the decline in the old custom of liming. A sample of the soil from one of the affected fields on this farm gave the following results when tested in the laboratory :—

Hygroscopic moisture	2·13 per cent.
Loss on ignition	8·03 „ „
Carbonate	Nil.
Lime requirement (calculated as $CaCO_3$) ...	·27 „ „
Action on litmus	Strongly acidic.

(4) In several cases where land has been laid down to grass, it has been observed that the clovers have more or less failed. Some of these cases have been specially investigated and have provided data of some interest as regards the probable cause of failure. The following example may be regarded as typical of such cases :—

A farmer made two unsuccessful attempts to lay a particular field down to grass. The soil was regarded as a very fertile loam and was apparently uniform in every respect throughout the field: although the clovers flourished satisfactorily in parts of the field there were isolated areas where they had failed completely. Samples of the soil were taken from each of the "failure areas" and also from the adjoining land on which the clovers thrived. Both sets of samples were analysed. The results showed that in mechanical and chemical composition all samples were alike except that those obtained from the "failure areas" were more acidic and had a higher lime requirement. This is shown in the following table :—

	Clover Areas. Average for 4 Samples.	*Failure Areas. Average for 5 Samples.*
Carbonate	Nil.	Nil.
Action on litmus	Slightly acidic.	Strongly acidic.
Lime requirement (calculated as $CaCO_3$)	0·078 per cent.	0·160 per cent.

In view of the obvious necessity for increased liming, and of the fact that "lime" for agricultural purposes may be obtained in at least three forms, viz., burned lime, ground quicklime and ground limestone, it is highly important that farmers should be aware of the conditions under which these various forms of lime may be most profitably used. It is the special object of this article to draw attention to some of the circumstances which may influence the value of ground limestone as a fertilizer. At present there are but relatively few farmers who view ground limestone with much favour. There appear to be several reasons for this :—

(1) Excessive claims made on its behalf have led to the application of dressings much too small to produce appreciable results.

(2) Its price has often been proportionate to the excessive claims.

(3) Variability as regards both composition and degree of fineness. This may be exemplified by the following analyses of samples received at the college laboratory :—

		Ground Limestone No. 1.	*Ground Limestone No. 2.*
	Percentage calcium carbonate ...	94·25	53·11
*Percentage fineness of particles	Below $\frac{1}{100}$ in. diameter	14·92	3·14
	Between $\frac{1}{100}$ in. and $\frac{1}{60}$ in. diameter	73·03	37·65
	„ $\frac{1}{60}$ in. „ $\frac{1}{25}$ in. „	10·80	35·09
	Above $\frac{1}{25}$ in. diameter	1·25	24·12

(4) Farmers have failed to realise its limitations. Limestone is very efficient in correcting sourness and in assisting chemical and bacterial actions, but is very inferior to burned lime for improving the texture of heavy clay soils. It often happens that a farmer's prejudice against ground limestone rests upon failure to secure any benefits from the application of only 4 or 5 cwt. per acre on stiff clay soils.

Among the reasons which may be advanced in favour of using ground limestone, the following may be enumerated : —

* See "Selection of Fertilizers," by J. J. Griffith, University College of Wales, 1915.

(1) High cost of fuel, especially in the case of limestone quarries situated away from coal areas.

(2) In districts where limestone is used for road repairs, definite testimony has been borne to its value by farmers who, recognising the superiority of that kind of road scrapings and ditch cleanings, have made a practice of using them.

(3) It is possible to secure much finer grinding than was practicable 15 or 20 years ago.

(4) During recent years laboratory methods for ascertaining the lime requirements of soils have been much improved. Now it is possible to give the farmer reliable guidance in this connection, so that he may know the minimum quantity of limestone needed to meet the requirements of his particular soil.

(5) In the case of soils with low lime requirement it is easier to apply small dressings of ground limestone than of lump lime.

Last year the writer conducted a pot experiment to ascertain the influence of degree of fineness upon the efficiency of ground limestone. Trefoil (*Medicago lupulina*) was chosen as the crop to be grown, because Wales is mainly a grassland country, and because the success of grassland farming is to be measured largely by the farmer's success in keeping up a high proportion of leguminous plants in the herbage. Further, Professor Lloyd Williams furnished the information that, under Welsh conditions of soil and climate, of the leguminous lime-loving plants, trefoil was particularly sensitive to the action of lime.

The carboniferous limestone chosen for the experiment was analysed and found to contain :—

	Percentage.
Moisture	·23
Calcium Carbonate	97·16
Magnesium Carbonate	·59
Iron and Aluminium oxides	·25
Matter insoluble in acid	1·32

The soil used in the pots was fairly typical of the sedentary soils on the Ordovician formation in Mid Wales. The soil was found to be acidic in its action upon litmus paper. Its lime-requirement, ascertained by shaking with a standard solution of calcium bicarbonate, was found to be equivalent to 1.25 per cent. of calcium carbonate (approximately equal to 25 cwt. per acre). Its mechanical and chemical composition is indicated in the subjoined table :—

(a) *Mechanical Composition.*	Percentage.
Moisture	2·7
Loss on ignition ...	10·6
Gravel	17·9
Coarse Sand	15·5
Fine Sand	15·0
Coarse Silt	15·4
Fine Silt	16·6
Clay	4·4

(b) *Chemical Composition.*	Percentage.
Nitrogen	·31
Total Phosphoric Acid (P_2O_5)	·089
Citric-soluble Phosphoric Acid	·006
Total Potash (K_2O) ...	·78
Citric-soluble Potash ...	·05
Total Lime (CaO) ...	·23
Total Magnesia (MgO)	·20
Carbonate	Nil.

The limestone was ground in a mortar and separated by sieves into four fractions of the degree of fineness indicated below :—

Fraction A. Particles below $\frac{1}{8}$ in. and above $\frac{1}{12}$ in. diameter.*
Fraction B. „ „ $\frac{1}{12}$ in. „ „ $\frac{1}{25}$ in. „
Fraction C. „ „ $\frac{1}{25}$ in. „ „ $\frac{1}{100}$ in. „
Fraction D. „ „ $\frac{1}{100}$ in.

The pots were filled with soil and seed was sown on May 15th, 1920. Pots 1, 2 and 3 for control received no limestone, while the soil in Pots 4 to 11 inclusive received an admixture of 0.3 per cent. ground limestone (approximately equivalent to 3 tons per acre). No manure was added to any of the pots. The treatment is indicated in greater detail in the following table :—

Pots 1, 2 and 3	No limestone.
Pots 4 and 5 ...	0·3 per cent. of limestone, particles $\frac{1}{8}$ in. to $\frac{1}{12}$ in.
Pots 6 and 7 ...	„ „ „ „ „ $\frac{1}{12}$ in. „ $\frac{1}{25}$ in.
Pots 8 and 9 ...	„ „ „ „ „ $\frac{1}{25}$ in. „ $\frac{1}{100}$ in.
Pots 10 and 11	„ „ „ „ „ below $\frac{1}{100}$ in.

Eighty seeds of trefoil were sown in each pot. By May 23rd the seedlings appeared in all pots. They did not, however, thrive in any pot. In fact they were of a poor colour, appeared to be in a very critical state, and made but very slight progress up to June 10th. At this date, however, the plants in pots 10 and 11 appeared to have greatly improved in colour and were making headway. The plants in the other pots did not improve much for another fortnight. On June 28th the plants were thinned down to 40 individuals to each pot.

* That it is practicable to grind limestone so that the greater part of it would pass through a 100 mesh to inch sieve is shown by the following results recently obtained by the writer in examining a sample of ground limestone :—

Particles $\frac{1}{8}$ in. to $\frac{1}{12}$ in.	0·14 per cent.
„ $\frac{1}{12}$ in. „ $\frac{1}{25}$ in.	1·63 „
„ $\frac{1}{25}$ in. „ $\frac{1}{100}$ in.	7·15 „
„ below $\frac{1}{100}$ in.	91·08 „

On July 31st the crop was cut and subsequently air-dried and weighed. The results are shown in the following table :—

Treatment Limestone.	Nil.			Particles $\frac{1}{8}$ in.—$\frac{1}{12}$ in.		Particles $\frac{1}{12}$ in.—$\frac{1}{25}$ in.		Particles $\frac{1}{25}$ in.—$\frac{1}{100}$ in.		Particles below $\frac{1}{100}$ in.	
No. of Pots	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Wt. of air-dried crop in grms. -	2·6 ;	2·5;	2·5;	3·3;	3·0;	3·6;	3·2;	4·7;	4·1;	9·6;	11·0.

As indicated in the illustration and figures given above, the ground limestone of a degree of fineness below 1/100 in. benefited the crop to a remarkable extent. With 1/25 in. to 1/100 in. the benefit was slight, while in the case of the two coarsest grades the effect was almost inappreciable. The pots were allowed to remain without any further treatment to provide a second crop.

The second crop of trefoil was cut on November 29th. The results are given below :—

	Control.			Particles $\frac{1}{8}$ in.—$\frac{1}{12}$ in.		Particles $\frac{1}{12}$ in.—$\frac{1}{25}$ in.		Particles $\frac{1}{25}$ in.—$\frac{1}{100}$ in.		Particles below $\frac{1}{100}$ in.	
No. of Pots	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Wt. of air-dried crop in grms. -	1·0;	1·2;	1·2;	1·3;	1·4;	1·3;	1·8;	1·5;	1·7;	23·2 ;	24·3.

The results given above indicate very clearly that the trefoil did not respond to any appreciable extent to ground limestone which could not pass through the 1/100 in. mesh sieve. In the case of the finest grade (below 1/100 in.) the effect upon the crop was very marked. It should be observed that the superiority of the finest grade was even more striking with the second crop than with the first. It is thus evident that particles above 1/100 in. not only failed to have any appreciable immediate effect upon growth, but also did not succeed in assisting the crop even several months after application. Another feature of the experiment, of considerable interest from the practical farmer's point of view, is the large number of plants which perished during the first few weeks after germination, both in the control pots and in all the pots to which the grades of limestone above 1/100 in. were applied. In the case

FIG. 1.—Showing the first crop of Trefoil, on 19th July, 1920

FIG. 2.—Showing the second crop of Trefoil, on 25th October, 1920.

of pots 10 and 11, *i.e.*, those treated with limestone below 1/100 in., very few plants died.

Several American experiments* have been conducted in order to ascertain the degree of fineness to which limestone should be ground. The results obtained regarding the desirable degree of fineness vary from 1/50 in. to 1/100 in.

In certain circumstances coarsely ground limestone might meet crop requirements. There are conditions, however, in farming practice which would appear to make the finest possible grinding advisable. A high degree of fineness facilitates thorough incorporation with the soil. This is of greater importance with the application of small quantities than it is with heavy dressings, and ground limestone is often applied in relatively small dressings. Again, the trefoil pot experiment, referred to above, shows that during the season of application the coarser particles may have but little if any beneficial effect upon the crop. There are occasions when it is particularly important to supply lime in such form as will assist the plant during the season of application. In many cases it would be applied at that point in the rotation when the grass and clover seeds are sown. In such a case the degree of fineness of the limestone, and therefore its availability for the plant during the first year, which is often a critical period, might decide whether the laying of the land down to grass was a success or failure.

Reference has already been made to the fact that in many districts farmers have lost faith in ground limestone on account of its "failures." Most of these "failures," however, can be explained readily as arising from the *improper* use of ground limestone. For example, in the hilly districts of Wales many cases have come under observations where *unsuccessful* attempts have been made to improve pasture land by the application of 5 or 6 cwt. per acre of ground limestone. The distinctive feature of the soils in the cases examined were (*a*) richness in organic matter, (*b*) a high degree of acidity, and (*c*) a particularly high lime requirement.

During the years 1914-15 the Agricultural Department of this College carried out an experiment† to ascertain the most suitable manurial treatment for upland pastures. The report states that

*Lyon, Fippin and Buckmann, "Soils, their Properties and Management," p. 540. Maryland Agricultural Experiment Station, Bulletin No. 193, p. 45. Pennsylvania Experiment Station, Bulletin No. 149, p. 21. Agricultural Experiment Station of the Rhode Island State College, Bulletin No. 180.

† "The Improvement of Upland Pastures," by Jones and Stapledon.

" by the second year the limed plot shows practically identical results with the unmanured." The writer was requested to sample the soil of the various plots in order to ascertain their lime requirements. As indicated in the table given below, soil samples were taken from :—(1) Fescue pasture areas, (2) areas containing a high proportion of white clover, (3) *Molinia* pasture areas, (4) peaty layer 1 in. to 2 in. depth covering the fescue areas.

Table showing lime requirement of soil from various plots.

No. of Sample.	Description of Sample.	Manurial treatment of plot.	Lime requirements calculated as $CaCO_3$ percent.*
1	Sample of the peaty surface of the fescue area	B. slag	0·974
2	Sample of soil, fescue area, Plot I	„ „	0·430
3	„ „ „ „ „ „ II	„ „ muriate of potash	0·420
4	„ „ „ „ „ „ III	Lime, superphosphate, muriate	0·460
5	„ „ „ „ „ „ IV	Lime, superphosphate	0·430
6	„ „ „ „ „ „ V	Lime, 10 cwt. per acre	0·390
7	„ „ „ „ „ „ VI	No manure ...	0·460
8	„ „ „ clover „ „ I	—	0·295
9	„ „ „ Molinia „ „ IV	—	1·065
10	„ „ „ bog land adjoining plots	—	0·735

The figures given in the table show that the lime-requirement of the soil of the Fescue pasture was very high (samples 2 to 7) and that it was still higher in the case of the *Molinia* pasture (sample 9). In the isolated spots where the clovers flourished the lime requirement was much lower (sample 8). The lime-requirement of the surface peaty layer overlying the Fescue area (sample 1) was so high that if a small dressing of lime were applied it would be used up before it reached the underlying portion of the soil. Further, the lime-requirement figures in general were so high that it could not reasonably be expected that a small dressing of lime would lead to much improvement. The nature of the soil on these plots was fairly representative of hill soils in Mid Wales. It is, therefore, not surprising that small dressings of ground limestone applied to upland pastures have often been " failures." This experiment was conducted in the district of which Thomas Johnes wrote, and it explains the

* 1 per cent. lime requirement is approximately equivalent to 1 ton per acre for a soil 9 in. deep.

truth of his statement that "lime, when laid on in large quantities, has in this country a wonderful effect."

General Conclusions.

(1) Liming as a general farm practice must receive more attention if soil fertility is to be raised and food production increased.

(2) Great losses must be taking place in connection with the pasture land of the country because soils are deficient in lime when grass and clover seeds are sown.

(3) In view of both the increased cost of fuel and the improvements which have been effected in the construction of pulverizers and crushers, ground limestone may under many circumstances be advantageously taken as a substitute for burned lime.

(4) A demand for ground limestone may lead to the opening up of disused quarries outside coal areas, and may thus establish new centres of distribution.

(5) There appear to be various reasons why expenditure on ground limestone has often been unremunerative in the past, viz. :—

(*a*) Coarseness of grinding.

(*b*) More impure limestone used for its manufacture than was the case for the production of burned lime.

(*c*) The smallness of the dressings which have often been applied to soils which needed fairly heavy liming.

(*d*) The exorbitant prices which have on occasions been charged for it.

REPORT ON POTATO TRIALS, 1920.

Introduction.—Official statistics for 1920 show that the acreage of potatoes in England and Wales was 544,615 acres, with a total yield of 3,151,000 tons. These statistics relate only to holdings of more than 1 acre in extent, so that the true acreage of potatoes in the country must be considerably in excess of this figure, as potatoes are grown on most small holdings and allotments, and in private gardens.

The total value of this crop to the Nation directly and in terms of money cannot be less than £25,000,000, so that the industry is of great economic importance. Moreover, the food value of the crop is unquestioned. Its importance, as shown by the above figures, is such as to justify, and in fact necessitate, the carrying out of experiments and demonstrations to throw more light on many of the more complex matters of cultivation; to discover and demonstrate to the public the superior cropping capacity of new varieties of potatoes on particular types of soil; to demonstrate the value of a complete manure such as that which gave the most satisfactory results in the trials of potatoes carried out by the Irish Department of Agriculture in previous years; and to increase supplies of those varieties possessing great powers of resistance to the many diseases. The most important problem affecting potatoes with which the Ministry is at present faced is the safeguarding of the crop against Wart Disease by the growing of immune varieties on infected land, and therefore the varieties selected for these demonstrations were mainly those sorts which have proved immune to Wart Disease. The trials should provide figures showing the most profitable of these to grow, and where a satisfactory yield is obtained, these trials serve a useful propaganda purpose in connection with the control of this disease.

The growing of the very early varieties for lifting green has now become an important industry to many growers, and especially to those with a limited amount of land situated near large centres of population, so that trials to compare the cropping capacities of some of the early immune varieties with those of such popular susceptible varieties as "Epicure," "May Queen," and "Ninetyfold" were needed. The Ministry's scheme was prepared with due consideration to these points, and was circulated to County Horticultural Committees, with a request that they would carry out trials of

potatoes in their respective areas on the lines laid down in the scheme, the details of which were given as follows :—

Ministry's Scheme for Potato Demonstration Plots, 1920.—The main objects of the scheme are for the purposes of:—

(a) Finding out those varieties best suited to the different districts;

(b) Demonstrating approved methods of potato culture.

Wart Disease.—The Ministry requires the planting of immune varieties in those areas in which Wart Disease is known to be common and widespread, and in such areas Committees should use immune varieties only for their trials: whilst Committees in the "clean" districts should demonstrate the value of these immune varieties, and test their comparative merits with well-known susceptible kinds.

Supply of Seed.—The source of the seed potato influences the resultant crop to such an extent that all the seed should be obtained from the same source. It is advisable, therefore, that the seed, which will be Scotch Seed, should be purchased in bulk by the Ministry* and distributed to the various Committees. The seed potatoes will be invoiced at cost price to the Committees.

Quantity of Seed.—In carrying out these trials 14 lb. of each variety should be planted on land, which has been prepared according to the instructions given below.

Manures.—The land should receive farmyard manure at the rate of 15—20 tons per acre, and, preferably, to be applied in the drills at the time of planting: and artificials at the rate of:—

Superphosphate (26 per cent.)	4½ cwt. per acre.
Sulphate of Ammonia	1 „ „ „
Sulphate of Potash	1 „ „ „

Varieties.—The trials should be divided into two main sections :

Part 1.

Demonstration of the cropping powers of the well-known immune kinds such as Great Scott, Arran Comrade, Majestic, Kerr's Pink, Golden Wonder, Tinwald's Perfection and Favourite.

Part 2.

Early Variety Trials.—It is considered to be important to institute trials to test the earliness and cropping

* Later it was found to be more practicable to indicate sources of supply to County Committees.

qualities of certain early varieties. It must be realised that certain varieties are grown and marketed as earlies, which are not really earlies, if regarded from the point of view of maturity. "Epicure" is a good example of this. It is a variety which "bulks" quickly, and can be marketed early; yet, if judged by its date of maturity, it is a second early. The same remark applies to "Eclipse" and "Sir John Llewellyn."

It has been frequently stated that "King George," if well grown, will be ready for lifting quite as soon as "Epicure." Last season, in many districts, "Arran Comrade" matured earlier than "Epicure." It is, therefore, of the greatest importance that this problem of earliness should be tested in a thorough manner in all these districts where early potatoes are grown.

NOTE.—The Trials of Early Varieties are for the express purpose of comparing the earliness of some particular varieties. To obtain reliable results it is obvious that the seed of the many kinds must all come from the same source, be treated in a similar way, planted on the same date, and the crop given equal opportunities for development. It has been indicated before that it is not merely the determination of a date when the crop matures, but of a period when the crop may be profitably marketed. This is a point that should be well considered.

The instructions regarding supply of seed, manuring, &c., are the same as for the cropping trials.

Varieties as Controls for 1920.—Three of the leading well-known susceptible first earlies, "Duke of York," "Ninety-fold" and "Epicure," should be grown as controls with which the new varieties may be compared. These new varieties are Dargill Early, Arran Rose, King George, Nithsdale, Arran Comrade, Snowdrop.

Planting.—The time of planting will vary slightly according to the district. The trials should be planted at what is considered a suitable time for planting potatoes in the district. It is suggested that a distance of 26 inches between the drills and 12 inches between the sets should be adopted throughout all the trials. Any departure from these distances should be noted in the reports of the trials.

Reports.—It is suggested that Committee will prepare a full report of the trials for the benefit of farmers and allotment holders. The Ministry will also require a brief report drawn

up on certain definite lines in order that they may issue a summarised report of all the trials in the Country.

It was recognised that, although County Committees might arrange local schemes in their Counties, which would provide much valuable information to local potato growers, trials carried out on uniform lines in every County with seed from one source and with a uniform system of manuring, would supply this local information equally well and, in addition, further reliable information of national importance. It was for this reason that the scheme was prepared by the Ministry, and provisions made for the supply of seed.

Number of Centres.—The County Committees adopting the scheme made such arrangements to carry out the trials as were consistent with local conditions. Most Committees selected the Farm Institute—where one existed—for the site of the trials, but selected other centres in their areas as well, the total number of centres at which the trials were conducted being 455. In most cases the cost of the seed and manures alone had to be defrayed from public money, the land and labour being provided by private persons (farmers, small-holders and allotment-holders) in return for the crop produced. It is a pleasure to be able to record the satisfactory working of this plan, which had many points of great value; it allowed the trials to be carried out on commercial lines under the close attention of growers themselves, and relieved Committees of the responsibility of hiring or buying land, and from further financial transactions—a burden at all times to public bodies.

Finance.—As the trials were carried out in connection with the Educational policy of the Ministry, they were aided by the Department to the extent of two-thirds of the actual deficit cost. At the moment, details of the actual cost cannot be given.

Results.—Space does not permit of detailed results of every County trial being given in this Report. Most of these results have already been published locally, and it only remains for the Ministry to compile a report which will correctly interpret the sum total of the results from the many trials.

The correct interpretation of the results obtained from cropping trials is always a difficult matter because of errors which cannot be eliminated from field experiments. The value of such experiments depends upon the degree of confidence which can be attached to the results, *i.e.*, on the probability that similar results will be obtained when the trials are repeated. It follows,

therefore, that the more numerous the number of similar experiments the more convincing are the results.

It is true that *results* obtained at any one station or from several stations in any one County, might be unconvincing or even misleading; but some reliance can surely be placed on the results from carrying similar experiments out at 455 stations situated through England and Wales.

A review of the yields of each variety averaged for all the centres, shows at once how consistently and well the variety *Kerr's Pink* cropped, yielding the highest crop in 26 out of 35 English Counties carrying out trials. *Majestic* gave the largest yield in Essex, Hereford and Kent; *Arran Comrade* in Bucks, Lincolnshire (Lindsey), and Norfolk; *Great Scott* in Durham; *King George* in Cheshire, and *Epicure* in Berks. In Wales *Kerr's Pink* again did well, giving the largest yield in 4 Counties (Radnor, Monmouth, Montgomery and Anglesey); *Arran Comrade* in 3 Counties (Brecon, Cardigan and Carnarvon); *Great Scott* in 2 Counties (Carmarthen and Pembroke), and *Majestic* in Denbigh and Flint.

From the results summarised for the whole country, as shown below, it was found that the average yield of second early and maincrop varieties in these trials was 10 tons 6 cwt. per acre. This figure is greatly in excess of that for the estimated average yield of potatoes for the whole of England and Wales in 1920 (5 tons 16 cwt. per acre), and from this fact it would appear that provided better seed is used and the land adequately cultivated and manured, there is no reason why the yield per acre for the whole country should not be materially increased.

The following figures show the Average Yield of each Variety for all Centres:—

	Snowdrop.	Dargill Early.	Great Scott.	Majestic.	Kerr's Pink.
	Tons. Cwt.	Tons. Cwt.	Tons. Cwt.	Tons Cwt.	Tons. Cwt.
Average Yield in England, 390 Centres	8 3	8 0	12 2	10 12	13 12
Average Yield in Wales, 65 Centres	6 13	7 7	10 2	9 11	11 8
Average Yield in England and Wales, 455 Centres...	7 16	7 17	11 13	10 7	13 2

	Golden Wonder.	Tinwald Perfection.	Favourite.	Arran Rose.	King George.
	Tons. Cwt.	Tons. Cwt.	Tons. Cwt.	Tons. Cwt.	Tons. Cwt.
Average Yield in England, 390 Centres	8 9	10 6	5 18	7 9	11 10
Average Yield in Wales, 65 Centres	8 1	8 18	5 17	7 1	11 5
Average Yield in England and Wales, 455 Centres...	8 7	10 0	5 18	7 7	11 9

	Nithsdale.	Duke of York.	Ninetyfold.	Epicure.	Arran Comrade.
	Tons. Cwt.	Tons. Cwt.	Tons. Cwt.	Tons. Cwt.	Tons. Cwt.
Average Yield in England, 390 Centres	10 0	8 16	8 14	11 11	11 10
Average Yield in Wales, 65 Centres	8 12	10 1	10 1	—	11 1
Average Yield in England and Wales, 455 Centres...	9 14	8 19	8 18	11 11	11 8

Table giving Summary of Average Yields per acre for England and Wales:—

First Earlies.

(a) Immunes.

	Tons.	cwt.
Dargill Early ...	7	17
Snowdrop ...	7	16
Arran Rose ...	7	7
Average ...	7	13

(b) Susceptibles.

	Tons.	cwt.
Epicure	11	11
Duke of York ...	8	19
Ninetyfold ...	8	18
Average ...	9	16

Second Earlies.

	Tons.	cwt.
Great Scott ...	11	13
King George ...	11	9
Arran Comrade...	11	8
Nithsdale ...	9	14
Average ...	11	1

Late and Main Crop.

	Tons.	cwt.
Kerr's Pink ...	13	2
Majestic ...	10	7
Tinwald Perfection	10	—
Golden Wonder...	8	7
Favourite ...	5	18
Average ...	9	11

From the table above it will be seen that so far as cropping powers are concerned, the first early immunes have considerable leeway to make up to equal the susceptible varieties which were used as controls. The final average for the three first early immunes is 2 tons 3 cwt. per acre behind the average of the three susceptibles, and *Dargill Early*, the highest cropping immune, is 3 tons 14 cwt. per acre behind Epicure, the highest cropping susceptible.

The second early varieties *Great Scott*, *King George* and *Arran Comrade* are very consistent with regard to their relative yields throughout the country. *Arran Comrade* has given heavy crops in *some* districts exceeding those of Kerr's Pink, as in Brecon, Carnarvon and Birmingham. *Nithsdale*, which is now regarded as a second early, has generally given considerably lower yields. It has, however, given heavy crops in the Northern Counties, the Midlands and in Wales.

Of the maincrop and late varieties, *Kerr's Pink* is at the top, and has given the heaviest average county crop, viz., 21 tons 9 cwt. per acre in Leicestershire. *Majestic* is a good second, with 19 tons 1 cwt. per acre in Hereford.

Unfortunately space will not permit of tables to be shown, to illustrate which of these varieties produce the higher proportion of ware potatoes in the crop.

Soil Influence.—An attempt has been made to show the effect of soil on the comparative cropping qualities of the many varieties.

Table comparing the Average Yields of the Varieties on Light, Medium and Heavy Soils:—

	Light. Per Acre.		*Medium.* Per Acre.		*Heavy.* Per Acre.	
	Tons.	Cwt.	Tons.	Cwt.	Tons.	Cwt.
Kerr's Pink	13	18	13	14	13	2
Epicure	12	16	10	19	9	17
Great Scott	12	5	11	15	10	5
King George	11	11	11	15	10	4
Arran Comrade	11	10	11	11	10	10
Nithsdale	10	19	10	10	8	9
Tinwald Perfection ...	10	8	9	13	8	18
Majestic	10	7	10	13	8	9
Ninetyfold	9	10	9	19	7	14
Duke of York	9	1	10	5	8	—
Golden Wonder... ...	8	11	8	17	7	11
Snowdrop	8	9	7	—	6	19
Arran Rose	8	2	7	16	5	13
Dargill Early	8	—	7	18	6	10
Favourite	6	4	5	11	5	6
Average yield of all varieties	10	2	9	17	8	10

The best results were obtained on light loamy soils, the varieties averaging 10 tons 2 cwt. per acre as compared with 9 tons 17 cwt. on medium soil, a drop of only $\frac{1}{4}$-ton per acre. *Arran Comrade* and *Duke of York* in fact gave a slightly heavier yield, but *Epicure* gave approximately 2 tons per acre less.

On heavy soils, the reduction in yield is more marked, the average yield being $8\frac{1}{2}$ tons per acre, or 1 ton 12 cwt. per acre less than on light soils. These figures are fairly consistent for most varieties, but *Epicure* appears to be more influenced by the texture of the soil than other kinds.

Speaking generally, most varieties have given the lowest yields on the heavy soils, while the heaviest aggregates have been obtained on light soils. The exceptions to this are *Duke of York*, *Ninetyfold* and *Golden Wonder* which have done best on medium soils. There is often difficulty in making recommendations for heavy soils, but the trials give some information on this point, *e.g.*, *Epicure* would appear to be the best susceptible early variety and *Snowdrop* the best immune; *Arran Comrade*, *Great*

Scott and *King George*, the best second earlies; and *Kerr's Pink*, *Tinwald Perfection* and *Majestic* are the best maincrop or late varieties.

On examining the average yields on light, medium and heavy soils for the whole Country, the following conclusions are indicated :—

(a) *Early Varieties.*—In the case of first earlies, the variety *Epicure* maintains its accredited position as the heaviest cropping early variety. It is only surpassed by *Kerr's Pink* when in competition on light soils with second earlies, maincrop and late varieties. On heavy soils it still retains first place, and apart from the fact that it is a susceptible variety, it shows great power of adaptability. *Duke of York* has cropped heavier than the immune varieties, and appears to be at its best on a medium soil. *Ninetyfold* also crops heavier on all soils than the early immunes. *Snowdrop* is the heaviest cropper amongst the immunes on light and heavy soils. *Dargill Early* takes the third place amongst the immunes on light soils, the first place on medium soils, and second place on heavy soils. *Arran Ros* takes second place amongst early immunes on light soils, second place on medium soils and third place on heavy soils.

(b) *Second Earlies.*—Amongst second earlies *Great Scott* holds the premier position, being the heaviest average cropper on light and medium soils, and only falls to the second place on heavy soils. *King George* takes the second place on light and medium soils and third place on heavy soils. *Arran Comrade* takes first place on heavy soils, with the very creditable average of 10 tons 10 cwt. per acre. It would appear to be the most suitable immune second early for a heavy soil, although *Great Scott* and *King George* closely follow it.

(c) *Main Crop and Late Varieties.*—Amongst these *Kerr's Pink* clearly demonstrates its superiority as a cropper and is on an average 1 ton 17 cwt. per acre ahead of all varieties on the three types of soil. It is of interest to note that this variety with a long season of growth gives the heaviest average on light soils. *Tinwald Perfection* takes second place on light and heavy soils but is beaten by *Majestic* on medium soils. *Golden Wonder* takes fourth place on all three types of soil. *Favourite* has done badly and has given the poorest results of any of the immunes.

Characteristics.—The addition of a section giving the characteristics of the varieties tested would increase the value of the report but would occupy too much space. Such information is given in the Supplement of the JOURNAL on the Cultivation, Composition and Diseases of the Potato, price 6d.

THE 1920 LINCOLN TRACTOR TRIALS.*

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IT is to be regretted that the report of the judges of the Lincoln Tractor Trials of 1920† should not have been published until some six months after the event, and that now that it is finally given to the public the report should contain so few details of the performances of the machines taking part. We may recall that the conditions governing the trials conducted by the Royal Agricultural Society were drawn up under the influence of a principle the reverse of that which had been adopted by the Society of Motor Manufacturers and Traders in the previous year. At the earlier trials the performance of each machine had been recorded, there had been no prizes or awards, and those interested had been left to draw their own conclusions.

The R.A.S.E. determined to follow an old practice and award prizes. The awards were announced at the conclusion of the trials, but it was expected that the basis of the awards would in due course be disclosed in the form of a record of the individual performances of the competing machines. We have previously expressed our grave doubts as to the wisdom of awarding prizes or instituting an order of merit in such cases, and we venture to think that the present report will not convert anyone to a belief in the value of prizes. We may go further and assert that the public interested in agricultural tractors have a moral right to be furnished with the recorded performances of tractors competing in public trials. Apart from the importance to farmers and manufacturers of knowing exactly the considerations which influenced the judges in awarding a prize, it should be possible for anyone to compare the actual performances of each tractor and further to compare the year's records with those of preceding years.

The only details of performance disclosed are contained in Table III under the heads of:—

Time in hours per acre.
Fuel in gallons per acre.
Wages in pence per acre.
Fuel cost in pence per acre.

* In continuation of "Notes on the Lincoln Tractor Trials, 1920," *Journal*, Nov., 1920, p. 714.

† Published by the Royal Agricultural Society of England, price 7s. 6d.

These give the minimum, the average of the five lowest, and the maximum in each class for heavy and light land, and under the head "Total cost of labour and fuel per acre" give the minimum and the average for the whole class. A note warns us that "the figures for minimum time and minimum fuel consumption per acre do not necessarily apply to the same tractor" and that "the same is the case for the maxima," and we are left in complete doubt as to the bearing of these figures on the awards.

If the object were to institute a comparison between classes of machines these figures would doubtless be of value, although we may express a doubt whether the classification adopted for the purposes of this competition has the highest scientific value.

It appears that in Class I (two-furrow tractor) the minimum time to plough an acre on light land was 1.58 hours, the maximum 2.33 hours; on heavy land 1.75 hours and 2.61 hours, respectively. In Class II (three-furrow tractor) the times were, for light land, minimum, 1.09 hours, and maximum 1.99 hours; for heavy land, 1.30 hours and 4.00 hours respectively. In Class VII (motor ploughs) on light land, minimum 1.46 hours and maximum 2.42 hours; on heavy land 1.30 hours and 3.22 hours respectively.

The consumption of fuel in gallons per acre was as follows:—

	Min.	Max.
Class I.—Two-furrow tractors, light land ...	2·63	5·41
heavy „ ...	3·42	5·51
Class II.—Three-furrow tractors, light land ...	2·06	4·12
heavy „ ...	2·96	6·51
Class VII.—Motor ploughs, light land ...	2·21	4·48
heavy „ ...	2·27	6·21

On the basis of 18d. per hour for each attendant, the wages worked out in pence per acre are as shown below. In the last two columns are given the total cost of labour and fuel per acre. The prices taken for the purpose of the table were:—Paraffin, 1s. 11d. per British gal.; petrol, 3s. 5d. net. per gal.

	Wages.		*Labour and Fuel.*	
	Min.	Max.	Min.	Average for whole class.
	d.	d.	s. d.	s. d.
Class I.—Two-furrow, light ...	28·5	44	7 5	9 5
heavy	31·5	47	9 2	10 11
Class II.—Three-furrow, light ...	19·6	35·8	5 7	8 4
heavy	23·4	72	7 7½	11 8
Class VII.—Motor ploughs, light	26·3	43·5	6 5	9 3½
heavy	23·4	58	6 3½	13 2

The figures for the total costs given in the table were taken on the actual acres ploughed, and represent the total per acre

for the items of attendants and fuel only, calculated on the net ploughing time and the total fuel used.

Average figures for five tractors in each class which performed the work in the shortest time and with the lowest fuel consumption are perhaps of more assistance than any other comparative figures for judging class against class; but comparison is vitiated by the warning that in any class the five speediest may not be the five most economical in fuel. Again, certain tractors were permitted to compete in both Classes I and II, and there is no indication as to whether or not the same tractor appears in the first five in both classes.

Class.	Land.	Average of Five Lowest.			
		Time in hours per acre.	Fuel in gal. per acre.	Wages in pence per acre.	Fuel cost in pence per acre.
I	Light	1·92	2·90	34·5	66·7
	Heavy	1·96	3·84	35·3	88·4
II	Light	1·21	2·96	21·8	68·0
	Heavy	1·52	3·63	27·4	83·5
VII	Light	1·89	2·84	33·9	65·3
	Heavy	2·08	3·78	37·4	86·9

The judges suggest that to compare the figures for fuel consumption it is convenient to adopt "equivalent acres," *i.e.*, "the number of acres that would have been ploughed if the drawbar pull had remained constant at 500 pounds per ploughshare, estimated from the actual drawbar pull observed and the actual area ploughed." The resultant figures cannot, however, be anything but arbitrary, and it seems better on the whole to adopt the actual recorded figures.

Accepting the figures at their face value it will be deduced that in the case of the more efficient tractors in each class there is very little to choose in the matter of fuel consumption, and that while the tractors pulling three-furrow ploughs had the advantage in time there is practically nothing between Class I (tractors pulling two furrows) and Class VII (motor ploughs). While these factors are of great importance, they are far from covering the whole range of questions which should determine the choice of a tractor, as for example:—Consumption of lubricating oil, dilution of lubricating oil by condensation of fuel, time taken to dismantle wheel grips, time taken to equip tractors for road-haulage, quite apart from a most important factor which short-period trials cannot be expected to discover, namely, cost of maintenance. Various

tests, such as uphill ploughing, road-hauling and belt work, were instituted, but only certain selected machines were subjected to each test and no comparative data are therefore available. No test was devised for demonstrating the advantage (if any) possessed by machines with three speeds over those with two speeds or one, a matter which certainly invites investigation and one which could easily be dealt with in a short-period trial. The important question of the relative advantage of wheels and caterpillar tracks is passed by with the remark that four "tractors were supported on chain tracks and in these no case was recorded of jamming by stones or other matter." Questions of adhesion, weight in relation to h.p., ranges of speed and many other points of importance are passed by in silence. The data being so scanty it follows that no useful purpose would be served in endeavouring to make a comparison between Classes I, II, and VII, and any of the other classes competing at the trials.*

It is indisputable that a report on short-period trials could be made much more informative than the present one. Clearly some of the points we have mentioned are not matters which can be dealt with adequately in the course of a few days or under the conditions which necessarily govern trials of this character; but still a very great deal can be done, and, as we have already indicated, a uniform annual report would supply comparative data of the utmost value, provided only that all modifications in design and particulars of the implements used were adequately recorded.

* Cf. *Journal*, Nov., 1920, p. 714

BEESWAX: METHODS OF EXTRACTION, AND THE PREVENTION OF WASTE.

W. HERROD-HEMPSALL.

WAX is not *gathered* by the worker bee, but is organically produced in her body from honey and pollen, by secretion. It is formed voluntarily by the bees filling their stomachs with honey, hanging in the hive in chain-like clusters, and remaining perfectly quiet for twenty-four hours. A good deal of pollen is consumed to make up for the wear and tear of tissue during wax secretion. During this period the wax glands convert the honey taken into their bodies into liquid wax, which exudes through tiny perforations into eight small pockets, or moulds, situated on the underside of the last four abdominal segments, where it hardens into small white scales (Fig. 1). It is then plucked out, made plastic by the admixture of saliva, and utilised for the building of the comb, the hermetic sealing of honey cells, and, with the addition of pollen, for the porous sealing of brood cells. It is computed that from ten to twenty pounds of honey are required to make one pound of wax. The work of wax secretion tells severely upon the vital powers of the bee, and being a valuable and costly product, none of it should be wasted.

When cleaning hives or appliances, a box should be kept for the collection of all refuse and burr combs. The scrapings from the floor board, which are generally thrown on the ground during spring cleaning, should be saved, although they contain a quantity of dirt and propolis, for there is generally sufficient wax to make it worth the trouble of collection and extraction. The honey combs used for extracting do not wear out, but last indefinitely; brood combs, on the contrary, become thickened by the cocoons and cast skins of the moulting larvæ, and must be continually renewed. Wax can therefore be obtained from old brood combs and the cappings from extracting combs.

Methods of Extraction.—The extraction of the wax may be made by using:—

(1) The Solar Wax Extractor.
(2) Steam.
(3) Boiling water.
(4) The heat of the oven.

The most efficient and economical method is the first. The cost of the extractor is the only expense incurred, as the sun

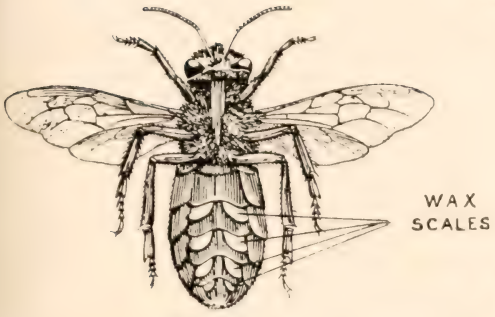

Fig. 1.—Drawing of Worker Bee, showing Wax Scales.

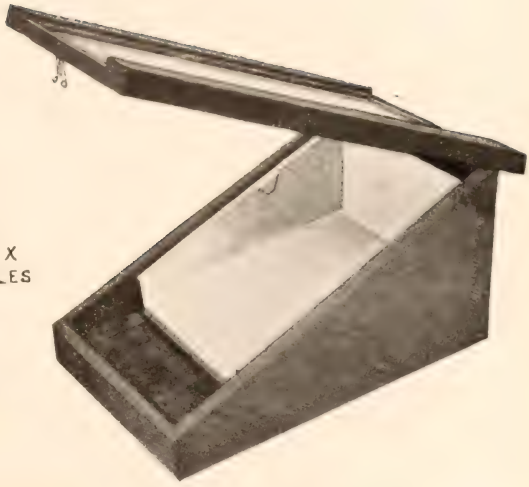

Fig. 2.—Solar Wax Extractor.

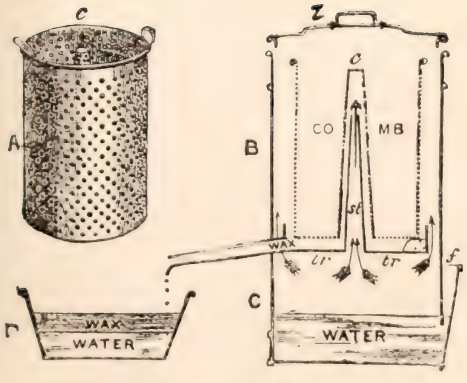

Fig. 3.—Gerster Wax Extractor.

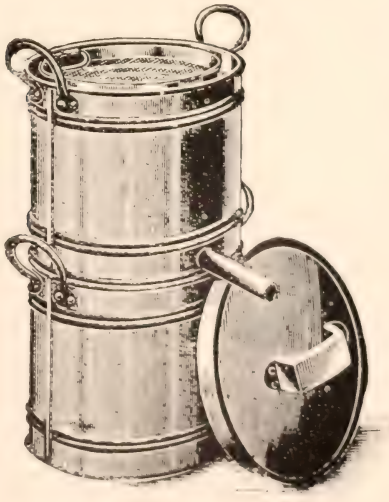

Fig. 4.—Cottinger Wax Extractor.

provides the necessary heat. The appliance is really a miniature garden frame, with a double glazed and hinged light (Fig. 2). Inside, the frame is fitted with a metal tray which slopes down to a tin trough covered with wire gauze. The extractor is placed in a sunny position and the material to be treated is spread thinly over the bottom of the metal tray. The wax melts and runs into the trough, being strained of impurities by the wire gauze covering. When the melted wax ceases to flow, the dross remaining in the tray is removed and a fresh supply of material given. Another advantage of this extractor is that no storage of old combs or refuse is necessary; these can be put in for treatment as collected.

If a garden frame is available, it can be used for extracting wax by placing the material to be treated in a perforated zinc tray over a metal box (such, for instance, as a biscuit tin), placed close up to the glass light. Wax extracted by solar heat improves in colour instead of deteriorating, as it may do when steam or boiling water is used.

The material to be extracted by methods (2) and (3) must be stored until required in an air-tight tin, for protection against the ravages of the wax moth. In the winter it can be melted over the kitchen fire by means of a Gerster wax extractor (Fig. 3). This is an arrangement similar to a domestic steamer, as illustrated in Fig. 3. It consists of a cylindrical, perforated, tin basket (A), having a cone-shaped tube running up the centre (c), which is also perforated, and open at the top to allow the steam to percolate right through the combs or wax that are placed in it for melting. The upper part of the appliance (B) consists of a circular shaped pan, having a false bottom or tray (tr.) about $1\frac{1}{2}$ in. deep. This is fixed so that there is a space between it and the wall of the pan, in order that the steam can pass up the sides and into the perforated basket, as indicated by the arrows.

From this tray the melted wax passes through a tube (indicated in the drawing by the word "*wax*"). There is also a cone-shaped tube (st.) running up from the tray, which fits very loosely into a similar perforated tube (c) in the basket. When placed in position, as shown in section at B, this is open at the top to allow the steam to pass through as indicated by the arrows, and thus permeate the wax or combs in the basket. The basket does not fit close down on the tray, but is raised about 1 in. on three legs. The bottom pan is for water only.

The method of working is as follows:—The perforated basket is filled with comb which has first been broken into small pieces; these should not be pressed down, but put in as loosely as possible. The basket is placed in position in pan B, and covered with the lid (l). Pan B is now fitted on pan c, which has previously been filled with rain water. The appliance is then put on the fire, and when the water boils the steam will pass in the directions indicated and will melt the wax from the combs in the perforated basket. The molten wax will ooze out through the perforations, run down the sides of the basket into the tray, and thence out of the tube, where it drops into cold rain water, contained in a vessel (D) placed for the purpose of receiving it. As soon as it is cold, the wax will be found to have set in a cake, when it can be lifted off. When all the wax has been extracted the dross is removed from the basket and the process repeated.

As the water boils away very rapidly it will be necessary to replace it from time to time; by means of the funnel (f) this can be done without removing the appliance from the fire.

Cappings from the shallow combs, when cut off for extracting the honey, can also be melted in the same manner. Before putting them in the basket, however, they should be drained free from honey, well washed in rain water, and dried in the sun.

A cheaper form of wax extractor is shown in Fig. 4. This is made on similar lines to the Gerster, but the cost is reduced by omitting the central cone-shaped tube; in all other respects it is identical. As steam is not admitted into the centre of the perforated wire basket, the operation of extraction is prolonged.

To extract wax by means of boiling water, the material should be tied in a bag made of porous fabric, such as cheese straining cloth, and stood on laths of wood placed across the bottom of a copper or saucepan, so that the bag does not touch the bottom. The bag should be weighted with a stone, and water then poured in until it flows above the bag. The water should then be boiled very gently. The melted wax will percolate through the bag and float on the water, and when cold it can be lifted off in a solid cake. A little dross will be found on the bottom of the cake, but this can be removed by scraping. If a well-cleansed sample is desired, the cake should be remelted in a similar manner, and cooled slowly. Rain water must be used in methods 2 and 3, as hard water contains lime, which would spoil the texture and colour of the wax. More wax will be obtained if pressure is

applied to the bag while boiling, and in the case of old combs, if these are well soaked in water previously to melting.

If only a small quantity of wax is to be dealt with, it may be placed on a piece of perforated zinc over a bowl of rain water, and put in the oven. The wax will melt and drop through the perforated zinc into the water; the impurities will remain on the zinc and can be thrown away. The bowl is then taken out of the oven and the water and wax allowed to cool, when the latter will have set in a cake and can be lifted off.

The melting point of pure beeswax is between 63° and 64° C., which is higher than that of any other wax. The colour, which varies from pale primrose to orange red, depends to a great extent upon the variety of pollen consumed by the bees. It is a curious fact that dark honey produces a light wax, while light honey yields one of a darker hue.

For commercial purposes the lightest coloured wax commands the best price, and therefore, before extracting, it is advisable to grade the combs. Those which have not been occupied by brood, and also cappings removed from combs previous to extracting the honey, will yield the best wax, and should be sorted out and melted separately from old combs, which will yield a darker and consequently less valuable wax.

It is unfortunately a fact that adulteration of beeswax sometimes occurs. The materials used for this purpose include tallow, stearin, paraffin, vegetable wax, resin, and ozokerit. Owing to their low melting point, the addition of any of these to beeswax used for making comb foundation is disastrous in its effect. The following are simple tests for detecting adulteration:—

(1) A small piece of wax placed in the mouth and chewed should not adhere to the teeth, or become pasty, but, generally speaking, should disintegrate into small fragments, and have no unpleasant taste.

(2) Place a piece of suspected wax (of the size of a small nut) into a test tube, half fill with spirits of turpentine, and carefully warm over the flame of a spirit lamp. If the solution is cloudy, or a deposit is thrown down, the solution is not complete, and the wax is adulterated, as spirits of turpentine completely dissolves pure beeswax.

A large quantity of wax is imported into this country from Germany, Holland, Madagascar, Chili, Brazil, and various other countries. The value of the importations in 1919 of beeswax, ozokerit, and earth wax was £1,045,415, of which the greater portion was probably beeswax. It is important, therefore, that none of this valuable material should be wasted, for when recovered and sold it will reduce to a considerable extent the large

sum of money hitherto spent on its importation. Further, by saving wax and having it made into comb foundation for his own use, the bee-keeper will add considerably to the profits of the apiary; the cost of manufacture is trifling compared with the price that has to be paid for the finished article.

Beeswax is used commercially for the following purposes :—

Comb foundation for bee hives.
Grafting wax for fruit trees.
Furniture and floor polish.
Waterproofing packing paper.
Boot polish and dubbing.
Candles for churches.
Plaster casting.
Cosmetics.
Salves.
Stopping teeth and making mouth models.

NOTES ON FEEDING STUFFS FOR JULY.

E. T. HALNAN, M.A.,
Ministry of Agriculture and Fisheries.

THE dry conditions existing over the greater part of the country have affected considerably the quantity and quality of pasture available for cattle at grass, and milch herds particularly will need a certain amount of cake if the milk yield is to remain satisfactory.

Barley and Barley By-products.—Barley, once a valued grain for bread-making, is now used almost exclusively for brewing and stock feeding. In regard to its protein constituents barley occupies a position intermediate to oats and maize, has less oil than either of these grains, and contains more starchy material than oats. It forms quite a good feed for most stock, although in Great Britain the greater part of the barley fed is used for pig fattening. For putting finish on fattening pigs, barley meal possesses a deservedly high reputation. In California rolled barley forms a common food for horses, and a mixture of oats and barley, sown in the proportion of one part of barley to two of oats is an excellent concentrate for milch cows. In feeding barley, particularly to fattening stock, the most suitable fodder to use with advantage is lucerne, sainfoin, or clover hay.

In brewing, the chief by-products obtained are malt sprouts (malt coombs) and brewers' grains. In obtaining the malt used by the brewer, the grains are allowed to germinate until the sprouts are well developed. The temperature is then raised to kill the grains, which are then dried off. The separated, dried, shrivelled sprouts are marketed as *malt coombs*, the dried grains themselves forming the malt. These malted grains are then steeped in the brewing vats, and after treatment, the residue left is called *wet brewers' grains*, and has a ready sale as feed for milch cows. In most cases, the wet brewers' grains are dried off and sold in the dried condition as *brewers' grains*.

Dried Brewers' Grains.—Dried brewers' grains form a somewhat bulky feed, and are not suitable for pig feeding. They may be fed safely to dairy cattle, and may replace up to half the usual oat ration for horses.

NAME.	Price per Qr. s.	Price per Qr. lb.	Price per Ton. £ s.	Manurial Value per Ton. £ s.	Food Value per Ton. £ s.	Starch Equiv. per 100 lb.	Price per Unit, Starch Equiv. s.	Price per lb. Starch Equiv. d.
Barley, English Feeding	43/9	400	12 5	1 6	10 19	71	3/1	1·64
„ Canadian „	42/-	400	11 15	1 6	10 9	71	2/11	1·56
Oats, English „	46/-	336	15 7	1 9	13 18	59·5	4/8	2·50
„ Argentine „	30/6	320	10 13	1 9	9 4	59·5	3/1	1·64
Maize, Argentine*	50/-	480	11 13	1 5	10 8	81	2/7	1·38
Beans, English spring	—	—	—	—	—	—	—	—
„ „ winter	56/-	532	11 16	3 1	8 15	66	2/8	1·43
„ Rangoon	8/3	112	8 5	3 1	5 4	66	1/7	0·85
Peas, English blue	60/-	504	13 7	2 13	10 14	69	3/1	1·65
„ „ dun	75/-	504	16 13	2 13	14 0	69	4/1	2·19
„ „ maple	80/-	504	17 16	2 13	15 3	69	4/5	2·37
„ Japanese*	117/6	504	26 2	2 13	23 9	69	6/9	3·61
Buckwheat	71/-	392	20 6	1 9	18 17	53	7/1	3·79
Rye, English	57/3	480	13 7	1 8	11 19	72	3/3	1·74
Millers' offals—Bran	—	—	6 15	2 10	4 5	45	1/11	1·03
„ „ Coarse middlings	—	—	8 15	2 10	6 5	64	1/11	1·03
Barley meal	—	—	14 5	1 6	12 19	71	3/8	1·96
Maize „	—	—	10 15	1 5	9 10	81	2/4	1·25
Fish „	—	—	20 10	7 12	12 18	53	4/10	2·59
Linseed	—	—	19 5	2 16	16 9	119	2/9	1·47
„ Cake, English	—	—	14 12	3 12	11 0	74	3/-	1·64
Cotton seed „ „	—	—	11 15	3 5	8 10	42	4/-	2·14
„ „ decorticated	—	—	14 0	5 6	8 14	71	2/5	1·29
„ Meal, decorticated	—	—	11 17	5 6	6 11	71	1/10	0·98
Coconut cake	—	—	10 2	3 0	7 2	79	1/10	0·98
Groundnut cake	—	—	9 2	3 9	5 13	57	2/-	1·07
„ „ decorticated	—	—	12 17	5 5	7 12	73	2/1	1·12
Palm kernel cake*	—	—	7 5	2 1	5 4	75	1/5	0·76
Brewers' grains, dried, ale	—	—	7 0	2 7	4 13	49	1/11	1·03
„ „ wet „	—	—	0 19	0 12	0 7	15	0/6	0·27
Distillers' „ dry	—	—	9 10	2 16	6 14	57	2/4	1·25
„ „ wet	—	—	—	—	—	—	—	—
Malt culms	—	—	7 0	3 6	3 14	43	1/9	0·94

* Price at Liverpool.

NOTE.—The prices quoted above represent the average prices at which actual wholesale transactions have taken place in London, unless otherwise stated, and refer to the price ex mill or store. The prices were current at the end of May and are, as a rule, considerably lower than the prices at local country markets, the difference being due to carriage and dealers' commission. Buyers can, however, easily compare the relative prices of the feeding stuffs on offer at their local market by the method of calculation used in these notes. Thus, suppose palm kernel cake is offered locally at £10 per ton. Its manurial value is £2 1s. per ton. The food value per ton is therefore £7 19s. per ton. Dividing this figure by 75, the starch equivalent of palm kernel cake as given in the table, the cost per unit of starch equivalent is 2s. 1d. Dividing this again by 22·4, the number of pounds of starch equivalent in 1 unit, the cost per lb. of starch equivalent is 1·11d. A similar calculation will show the relative cost per lb. of starch equivalent of other feeding stuffs on the same local market. From the results of such calculations a buyer can determine which feeding stuff gives him the best value at the prices quoted on his own market.

Wet Brewers' Grains.—Owing to their watery nature and cost of transport, skill is needed in feeding wet brewers' grains to dairy cattle, and care must always be taken to feed the grains

in a wholesome condition and in *clean* troughs. In some parts of Kent, wet brewers' grains are stored in practically air-tight pits, a certain amount of salt being added when filling the pits. Under these conditions wet grains will keep perfectly sound and wholesome for months. Unless some such method of keeping wet grains is available, their use for feeding dairy cattle is impossible unless the farm is within easy road distance of a brewery.

Malt Sprouts or Malt Coombs.—Malt coombs form a fairly bulky food, a good sample being light yellow in appearance, and having a very pleasing odour. Fed judiciously this feeding stuff is appreciated by cattle, sheep and horses. Dairy cattle may be fed up to two or three pounds per head daily. In feeding large quantities it is advisable to soak for several hours before feeding, since malt coombs swell considerably in water.

Barley Feed.—This by-product is obtained in the manufacture of pearl barley, has about the same feeding value as wheat bran, and is not usually available in the English market, such quantity as becomes available usually finding its way into compound meals and cakes.

The following figures compiled from various sources give an idea of the composition of barley and its by-products:—

	Water.	*Protein.*	*Oil.*	*Fibre.*	*Starchy material.*	*Ash.*
Feeding Barley ...	14·9	8·6	1·5	4·5	67·9	2·6
Brewers' grains (wet)	67·6	7·5	2·8	6·1	14·6	1·4
„ „ (dry)	10·3	18·3	6·4	15·2	45·9	3·9
Malt Coombs ...	10·0	24·4	2·0	14·0	42·4	7·2
Barley Feed	10·2	12·7	3·4	7·8	61·7	4·2

SUMMARY OF THE SEEDS REGULATIONS, 1921.

THE main provisions of the Draft Regulations under the Seeds Act, 1920, are as follows *:—

REGULATION 2 specifies the kinds of seed to which the Act applies and includes all the principal kinds of grasses, clovers, cereals, field seed, garden seed, flax seed, linseed and forest tree seed. Seed potatoes are also included under the Act.

REGULATION 3 sets out the particulars to be stated in the case of a sale or exposure for sale of seeds or seed potatoes and may be summarised as follows:—

Seed Potatoes.

(1) Name and address of seller.
(2) Class, *i.e.*, Class 1 (Scotch); Class 1 (Irish); Class 1 (English once grown); Class 2.
(3) Variety.
(4) Size and dressing.

The terms "Class," "Variety," "Size and Dressing" are defined and special concessions are made in the case of seed potatoes sold "as grown."

Grass and Clover Seed.

(1) Name and address of seller.
(2) That the seeds have been tested in accordance with the provisions of the Seeds Act, 1920.
(3) Kind of seed.
(4) Country of origin.
(5) Percentage of purity.
(6) Percentage of injurious weeds where it exceeds 1 per cent. in the case of clovers or 2 per cent. in the case of grasses.
(7) Percentage of germination.
(8) Percentage of pure germinating seed ("Real value").
(9) The bushel weight in the case of rye-grasses.
(10) The presence of Dodder if present to the extent of more than one seed in 1 oz. of Wild White Clover or in 2 oz. of Alsike or White Clover or Timothy, or in 4 oz. of Red or Crimson Clover or Lucerne.
(11) The presence of Suckling and other specified clovers when present to the extent of more than 2 per cent. in White, or Wild White or Alsyke Clover.
(12) The presence of Burnet if present to the extent of more than 5 per cent. in Sainfoin.
(13) The percentage of hard seeds in Clovers, Trefoil, Lucerne and Sainfoin.

* Copies of the draft regulations may be obtained on application to the Secretary, Ministry of Agriculture and Fisheries, 10, Whitehall Place, S.W.1.
Copies of the Seeds Act, 1920, may be obtained either directly, or through any Bookseller, from H.M. Stationery Office, Imperial House, Kingsway, W.C.1. (Price 2d. net).

(14) Minimum percentages of purity and germination are specified for the rye-grasses and such seeds testing at or above these figures may be so described without stating the actual percentages.

(15) With certain exceptions, all the above particulars must be given in respect of each kind of grass and clover seed included in a mixture and also the proportion by weight of each kind of seed.

Cereal Seeds.

(1) Name and address of seller.

(2) That the seeds have been tested in accordance with the provisions of the Seeds Act, 1920.

(3) Kind of seed and distinctive name of variety.

(4) Percentage of germination, provided that if such is at or above the minimum percentage specified in the Regulations a statement to that effect, including the authorised minimum percentage, is sufficient.

Field Seeds.

(1) Name and address of seller.

(2) That the seeds have been tested in accordance with the provisions of the Seeds Act, 1920.

(3) Kind of seed.

(4) Percentage of purity if below 97 per cent.

(5) Percentage of germination, provided that if such is at or above the minimum percentage specified in the Regulations a statement to that effect, including the authorised minimum percentage, is sufficient.

Garden Seeds. (The same as in the case of *Field Seeds*, with the exception that the purity of carrot seed need not be stated unless it is below 90 per cent.

Packeted Seeds.—The particulars required in the case of a sale of garden seeds do not apply to packets of peas or beans (not exceeding 2 lb.) or of other garden seeds (not exceeding 8 oz.) if the following particulars are stated on the packet :—

(1) Name and address of seller.

(2) That the seeds have been tested in accordance with the provisions of the Seeds Act, 1920.

(3) Kind of seed.

(4) Percentage of purity if below 97 per cent. (or 90 per cent. in the case of carrot seed).

(5) Percentage of germination, provided that if such is at or above the minimum percentage specified in the Regulations a statement to that effect is sufficient.

(6) The Season in which the seeds have been packeted.

Flax Seed and Linseed.

(1) Name and address of seller.

(2) That the seeds have been tested in accordance with the provisions of the Seeds Act, 1920.

(3) Kind of seed.

(4) Country of origin.

(5) Percentage of purity.

(6) That Dodder is present if present to the extent of more than one seed in 4 oz.

(7) The percentage of germination.

Forest Tree Seed.

(1) Name and address of seller.
(2) That the seeds have been tested in accordance with the provisions of the Seeds Act, 1920.
(3) Kind of seed.
(4) Percentage of purity.
(5) Percentage of germination (except in the case of broadleaved species).
(6) Date of collection of seeds.
(7) Country of origin.

REGULATION 4 prescribes the injurious weed seeds to which reference is made in Section 3 of the Act and Regulation 3 (1) (e) and (j). Under Section 3 of the Act it is illegal to sell or sow seeds containing more than a prescribed percentage of these injurious weeds (the percentage has been fixed at 5 per cent. by weight), and under Regulation 3 (e) and (j) they must be declared to be present when present to a greater extent than 1 per cent. in the case of grass and 2 per cent. in the case of clover seed.

REGULATION 5 prescribes the method in which samples must be taken for testing, the quantity of seed to be used for testing, &c.

REGULATION 6 describes the circumstances in which a licence may be issued, exempting a sale of seeds from the requirements of Section 1 of the Act.

REGULATION 7 defines such terms as "percentage of purity," "percentage of germination," &c.

THE FIRST, SECOND, THIRD AND FOURTH SCHEDULES set out the "authorised minimum percentages of germination." In the case of sales of certain kinds of seed, when the percentage of germination is at or above the authorised minima, this fact may be declared instead of the actual percentage of germination.

THE FIFTH SCHEDULE prescribes the limits of variation which will be allowed in connection with discrepancies in the percentages of germination, purity, and of injurious weed seeds. For instance, where the percentage of germination is stated by the seller to be 90 per cent., it shall not be deemed to be incorrect if the seed is shown to germinate 6 per cent. more or 6 per cent. less than that figure.

THE REQUIREMENTS OF THE SEEDS ACT, 1920, COMPARED WITH THOSE OF THE TESTING OF SEEDS ORDER, 1918.

The provisions of the Seeds Act, 1920, and of the Draft Seeds Regulations, 1921, are mainly the same as those required under the Testing of Seeds Order, 1918, which has been in operation since January, 1918. There are, however, certain alterations which have been made in the light of the Ministry's experience in administering the Order. The principal alterations may be summarised as follows:—

Seeds Act, 1920.

1. *Power to issue Regulations.*—The Minister is empowered to issue Regulations for carrying the Act into effect provided that such Regulations are drafted in consultation with the interests concerned (Section 7 (1)).

2. *Tests, where and when to be made.*—Tests for the purpose of a declaration under the Act, in the case of seeds other than garden seeds, must be made either at an Official Seed Testing Station or at a private station licensed by the Ministry (S. 2. (1)). (Under the Order such tests may be made by anyone and at any place.) These tests must also be made within a period of twelve months before the date of sale instead of, as under the Order, the date of the test having to be declared if more than six months old.

3. *Injurious Weed Seeds.*—Section 3 prohibits not only the sale but also the sowing of seeds containing more than a prescribed percentage of injurious weed seeds.

4. *Administration of the Act*:—

(*a*) *Seedsman's right to know result of tests.*—A copy of the certificate of the results of tests carried out at the Official Seed Testing Station on samples drawn officially for control purposes must be sent to the owner of the seeds (S.4 (3)).

(*b*) *Ministry's power to require name of seedsman's supplier.*—If the results of a test of a control sample are unsatisfactory the Ministry may require the owner of seeds from which the control sample has been taken to furnish the name of the person from whom the seeds were previously obtained (*i.e.*, the wholesaler). In such a case the person in question must be supplied with a portion of the sample and a copy of the result of the Official test (S. 4 (5)).

5. *Civil Proceedings.*—If the purchaser of any seeds wishes to have a test made for the purposes of civil proceedings a sample must be taken within 10 days of delivery and divided into two parts, one part to be sent to the Official Seed Testing Station for testing and the other part to the seller.

6. *Transactions exempted from the Act.*—The Act does not apply to certain transactions particulars of which are given in this *Journal* for October, 1920, p. 606. Under the Order the exemptions included only a sale of seeds "as grown" and a sale for delivery outside the United Kingdom.

7. *Application to Ireland and Scotland.*—The Act applies to Ireland and Scotland as well as to England and Wales, with the exceptions that the internal seed trade of Ireland will continue to be regulated under the Weeds and Agricultural Seeds (Ireland) Act, 1909, and that the Regulations for Scotland are to be issued by the Scottish Board.

Seeds Regulations, 1921.

1. *Seeds controlled by the Act and not by the Order.*—The following seeds are scheduled under the Act but are not included under the Order:—

Seed Potatoes.	Sugar Beet.
Field Peas.	Flax seed and Linseed.
„ Beans.	Forest tree seeds.

2. *Tests.*—In all cases (except in relation to Seed Potatoes) a statement must be made that the seeds have been tested in accordance with the provisions of the Seeds Act, 1920.

3. *Seed Potatoes.*—The particulars to be given are similar to those required under the "Seed Potatoes Order, 1918," viz., a statement as to the class, variety, size and dressing (see Summary of Seeds Regulations, 1921, above).

4. *Grass and Clover Seed.*—The particulars to be given are similar to those required under the Order with the following additions:—

(*a*) the "real value" or percentage of pure germinating seed must be stated.

(*b*) the bushel weight of ryegrass is required.

5. *Flax Seed, Linseed, and Forest Tree Seeds.*—The particulars to be given in these cases are set out in the summary of the Draft Seeds Regulations, 1921, above.

6. *Packeted Seed.*—Sellers of these may either give the particulars required in the case of a sale of Garden Seeds (see Reg. 3 (1) (a), (b), (c) and (n)), or, print on the packet the particulars set out in the summary of the Seeds Regulations, 1921, above, which include a statement as to the season in which the seed was packeted. Under the Order, nothing had to be declared by sellers of packets if the germination and purity of the seeds were above "Standard."

7. *Samples.*—Tests for the purpose of a Declaration may now only be made on samples drawn in accordance with the methods which under the Order only applied to the drawing of "control" samples.

8. *Method of Testing.*—The method of testing under the Testing of Seeds Order has been what is known as the "Irish method." Under the Act this will be altered to the "Continental" or "Universal" method.

9. *Minimum Percentages of Germination.*—These are prescribed in Schedules 1, 2, 3 and 4 for various kinds of seeds. When the germination of the seed specified is at or above these percentages that fact may be stated instead of declaring the actual figures obtained as a result of a test. In the case of most of the garden and field seeds the minimum percentage is 5 per cent. higher than the "Standard" prescribed under the Order. The germination of mangold and beet is to be given as the percentage of germinating clusters and, not of the sprouts as hitherto. Minimum percentages are now prescribed for the ryegrasses.

Except in the case of small packets of seeds, where a statement is made that the seed is not less than the authorised minimum percentage of germination prescribed the minimum percentage in question must be given.

FEES CHARGED FOR TESTING AT THE OFFICIAL SEED TESTING STATION.

The following are the revised fees to be paid for samples tested at the Official Seed Testing Station:—

For samples of seed which the farmer himself is proposing to sow, 6d. per sample.

In the case of tests which a farmer requires for the purpose of a declaration for sale:—

	per sample.
Cereals	2/-
Roots and Vegetables, other than Mangold and Beet	3/-
Mangold, Beet, Grasses or Clovers	4/-

The address to which samples for testing should now be addressed is:—*The Chief Officer, Official Seed Testing Station, 18, Leigham Court Road, Streatham Hill, London, S.W.16*, but early in August it is hoped to transfer the Station to its permanent premises, Huntingdon Road, Cambridge. Notice will be given in the press when the transfer takes place.

Agricultural Machinery After the War.

THE Report on Agricultural Implements and Machinery (Cd. 1315) which has been prepared by a Committee acting under the Profiteering Acts, 1919 and 1920, is of very considerable interest to agriculturists. Farmers may be relieved to hear that despite the high prices which they have been asked to pay in recent years there is no evidence of profiteering, and certain of the figures quoted by the Committee will bring conviction to the most sceptical. The figures relating to churns can be put into an easily intelligible table :—

Year.	*Average List Price.* £ s. d.	*Average Selling Price.* £ s. d.	*Average Total Costs.* £ s. d.	*Average Profits.* s. d.	Per cent. of costs.
1914 ...	4 11 4	3 2 0	2 8 6	13 6	21.77
1919 ...	8 17 6	7 2 3	5 17 2	25 1	17.63
1920 ...	9 2 4	7 4 8	7 4 3	0 5	0.27

The Committee find that dealers are not acting other than fairly in their position of connecting link between manufacturer and farmer : their commissions do not seem unduly high.

A great deal of the report confirms the conclusions of the Departmental Committee on Agricultural Machinery,* particularly in regard to manufacture and export trade, although some of the statements of the more recent Committee are not made with the qualifications which the former Committee considered necessary. "The conservatism of the farmer," they say, "is proverbial, and manufacturers have had to contend with much inertia and prejudice in bringing their appliances to the notice of the farming public. Generations of farmers have looked with some degree of suspicion, often with undisguised hostility, upon any innovation, and this has been especially the case with the substitution of mechanically propelled implements in the place of horse-drawn machines. It has only been after much hesitation that the average farmer has allowed himself to be persuaded of the efficacy of new patterns and the labour-saving which their adoption would entail." This reads rather like the manufacturers' case : there is another side to the story, part of which the Report discloses.

The Committee found that in spite of a general consensus of opinion as to the desirability of standardisation, nothing definite had been done by manufacturers, and they refer to the notorious case of British plough types. "Such advantages as are derived from the present policy of manufacturing large varieties of types appear to be counterbalanced by the enormous economies to be

* Cmd. 506. Cf. *Journal*, April, 1920.

obtained by standardisation." Again, many firms have no effective costings system.

English firms are comparatively small and this is another element in cost. One circumstance which has an intimate relation to the size of English firms is the progressive decline of the export trade, although there have been gains in some directions, and until the War the export of engines and thrashing machines was considerable, particularly to Russia and Central Europe. Russia in fact absorbed nearly 40 per cent. of the total British exports of agricultural machinery. Although the Report does not say so in as many words, it is obvious that in a country of the size of the British Isles there cannot be really large production for the home market : a large foreign trade is essential before the economies of large scale production can be introduced. The most striking of the conclusions of the Committee is that " the industry will only resume its former healthy condition when the markets of Central and Eastern Europe are effectively reopened." That, it may be added, will not be of benefit only to the British manufacturer but to the British farmer as well, for a small production means higher relative costs and higher prices.

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Proposed International Potato Conference.

IT is proposed to hold an International Potato Conference at the Royal Horticultural Society's Hall, Westminster, London, on 15th, 16th and 17th November. A Joint Committee of the Ministry of Agriculture and the Royal Horticultural Society is making the necessary arrangements, and the programme will include the reading of a number of papers by experts, who will deal with various aspects of potato culture. Among the papers are the following :—

" Degeneration of Potatoes," by Dr. R. N. Salaman (England).

" Potato Breeding, Selection and Development Work," by W. Stuart (U.S.A.).

" Industrial and Commercial Uses of Potatoes," by H. V. Taylor (Ministry of Agriculture).

" Leaf Curl," by H. M. Quanjer (Holland).

" Life History of the Wart Disease Organism and its Relation to Immunity from Wart Disease," by Prof. Blackman (London).

" Recent research in Potato Blight," by Dr. Petherbridge.

" Leaf Curl" and " Mosaic in Potatoes," by A. D. Cotton (Ministry of Agriculture), and W. A. Orton (U.S.A.).

There will also be an exhibition of British varieties of potatoes, with specimens of diseases in this country, and descriptions of British methods of dealing with them. The

presidential address will be delivered by Sir Daniel Hall, K.C.B., F.R.S., Chief Scientific Adviser to the Ministry of Agriculture, and a full report of the conference will be published later in book form. The Committee understands that the National Potato Society will hold their annual show at the Royal Horticultural Society's Hall in conjunction with the conference. Mr. H. V. Taylor, of the Ministry of Agriculture, and Mr. R. Dykes, of the Royal Horticultural Society, are the honorary secretaries of the conference. All interested in potato growing are invited to attend and take part in the discussions, so adding to the common stock of knowledge on the subject.

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World's Poultry Congress and Exhibition.

THE first World's Poultry Congress, convened by the International Association of Poultry Instructors and Investigators, will be held at The Hague, Holland, on 6th-13th September this year. Delegates from many Governments, teaching and experimental institutions, poultry and other societies, as well as private individuals interested in poultry, will be assembled for conference and for exchange of ideas and experiences.

The Netherlands Government is co-operating in every possible way with the promoters of the Congress, which is under the patronage of Their Majesties The Queen and Queen Mother of Holland, while H.R.H. Prince Henry of the Netherlands is president of the honorary committee, the members of which consist chiefly of Ministers of the Netherlands Government. The executive committee which will make the necessary arrangements has been appointed by the Netherlands Minister of Agriculture, Commerce and Industry, and will have as its first president Dr. H. J. Lovink, of The Hague, and as its second president Mr. Ed. Brown, F.L.S., president of the British National Poultry Parliament.

The Congress will be divided into four sections, each of which will have its own bureau to regulate its work. The chairman of each section will be able to speak at least four languages, while all reports and other publications issued will be printed in at least three languages. A wide range of papers, written by many leading authorities in the poultry world, will be submitted for the consideration of the Congress. The Ministry of Agriculture will be represented officially, and has prepared a paper on "Poultry Education in England and

Wales." Membership of the Congress is open upon payment of a fee of £1, and all who are interested in the development of the poultry industry are cordially invited to attend. Arrangements have been made for the accommodation of visitors at fixed and reasonable rates. The programme includes excursions to neighbouring places of interest.

World's Poultry Exhibition.—Simultaneously with the Congress the World's Poultry Exhibition will be held. This will not be a competitive show, but an exhibition of the best breeds of poultry from various countries, as well as poultry houses and appliances, books and other literature, diagrams and photographs. There will be also scientific demonstrations illustrating the work of instructors and investigators. The countries represented at the Congress will have their own committees and sub-committees to arrange for the preparation and reading of papers and the preparation of exhibits. The honorary secretaries of the British Committee are :—

Prof. R. C. Punnett, M.A., F.R.S., Whittinghame Lodge, Cambridge.
Mr. T. R. Robinson, F.S.I., 3, Vincent Square, Westminster, London, S.W.1.

to whom all enquiries relating to the Congress and Exhibition should be addressed. Many countries are arranging to send exhibits of representative poultry and poultry appliances. No prizes will be awarded, but each exhibitor will receive a medal and diploma.

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London Fruit Exhibition.

UNDER the auspices of the Ministry, an exhibition—the first of its kind—of home-grown and imported fruit will be held in London in the autumn, when varieties of fruit grown in the United Kingdom will be placed in competition with varieties grown in the Colonies and in certain foreign countries. Such an exhibition will, it is anticipated, be extremely helpful to our own fruit growers as well as to those engaged in placing foreign and Colonial fruit on our markets. Although much of our home-grown fruit is good, the methods of presenting it on the market leave much to be desired, and our growers would be well advised to give close attention to this side of the exhibition.

The three largest shows for English fruit are those held annually at Wisbech, Maidstone and Worcester. This year these three shows will be incorporated in the London Fruit

Exhibition, which will also, it is hoped, include exhibits from Scotland, Wales and Ireland. Thus the autumn exhibition in London will be a national one, and the exhibits will be the best and most representative of the United Kingdom and properly comparable with those from Canada, California and other places.

The Ministry has appointed an advisory committee, which is already at work, to organise the exhibition, and it is hoped to announce in the Press at an early date the full programme, which will be of a novel and interesting character. The exhibition will also be of interest to the general public, whose knowledge, for instance, of the best varieties of apples for eating or cooking is too often limited to a chance purchase of a choice specimen. One of the results of the London Fruit Exhibition will undoubtedly be to popularise the best varieties of fruit and so stimulate growers in the United Kingdom to supply the increased demand for them.

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Courses in Fruit and Vegetable Preservation.

THE courses successfully inaugurated last season in fruit and vegetable preservation at the Ministry's Experimental Station, Campden, Gloucestershire, are to be continued until October during the current year, with the exception of the month of July. A course lasts a fortnight and covers fully every phase of the subject. The fee is 30s. Full particulars can be obtained from the secretary of the Station at Campden. As the accommodation for students is limited, early application is desirable.

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International Institute of Agriculture.

THE Permanent Committee of the International Institute of Agriculture at Rome has forwarded the text of a resolution passed at its last meeting, under which the distinction of "Membre donateur de l'Institut International d'Agriculture" may be conferred upon anyone who, being desirous of testifying in a practical way to the ideals of the Institute, presents either in money or in kind a gift of the value of not less than ten thousand lire. The names of donors will be inscribed on a marble tablet, which will be affixed in the building of the Institute at Rome. The first "Membre donateur" to be nominated is M. Victor Vermorel, Member of the National Agricultural Academy of France, a former Senator, who has recently given a generous donation.

In this *Journal* for April last (p. 5), brief particulars were given of the origin and constitution of the Institute. It was founded in 1905 to study the conditions of the world's agriculture, to collect and disseminate information on economic and technical agricultural questions, and generally to aid agriculture throughout the world. The best known feature of the Institute's work, however, is the preparation of monthly reports of the estimated world production of crops and available supplies. These are published very widely and appear in the newspapers of practically every civilised country. In addition to these statistics, the Institute issues a bulletin summarising the information given in technical publications throughout the world in regard to agricultural investigations, plant diseases, &c., and also a bulletin dealing with the economic side of agriculture.*

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Arable Dairy Farms: Restricted Programme.

ARABLE dairy farms, established by the Ministry for experimental purposes, have suffered from conditions that are part of the aftermath of war. It will be remembered that this form of dairying was made the subject of prolonged and satisfactory experiment at the Harper Adams College, Newport, Shropshire, and that the theory these experiments may be said to have supported is, in brief, that continuous cropping and soiling enable a farmer to keep a cow in the best possible condition on the produce of two acres or less. On the ideal arable dairy farm the land is under crops—chiefly forage crops—all the time. The cows do not graze, but are turned out every day for brief exercise.

When it was proposed to test the economic possibilities of arable dairy farming, arrangements were made for the establishment of ten demonstration holdings, and a commencement was made at nine centres, seven in England and two in Wales. Unfortunately, the cost of building increased enormously soon after the inception of the scheme; the construction of necessary accommodation was delayed, and ultimately, building prices increased to a point that removed the economic basis from certain of the undertakings. This will be readily understood when it is remembered that an arable dairy holding should carry at least twice the head of stock of a pasture holding and that the homestead must be proportionately larger. Following

* The chief publications of the Institute may be obtained from the Ministry. Particulars of subscription rates will be sent on application.

the conditions that prevailed in the building trade came the pressure for economy in public expenditure, so that of the nine holdings referred to above the Ministry felt compelled to relinquish six on which the buildings had made little progress, but retained three, Grampound Road (Cornwall), Hucknall (Notts.) and Denham (Bucks.). The abandonment of six of these farms is to be regretted for many reasons, but it is satisfactory to know that there are three holdings on which the work is so well advanced as to justify completion; these will be fully equipped and will serve as experimental holdings. Every effort will be made to place the results of the working before the farming community, and it is to be hoped that, if the experiments prove successful and the practical value of arable dairy farms is demonstrated, there will be, as conditions improve, such an extension of private enterprise as will provide on a strict economic basis for the needs of the community. Interest among farmers has been stimulated already by visits to Harper Adams College, where much of the pioneer work has been carried out, and the results justify a considerable measure of optimism.

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Fream Memorial Prize.

THE Fream Memorial Prize which is annually awarded by the Ministry to the candidate who obtains the highest marks in the examination for the National Diploma in Agriculture, has been won this year by Mr. William Riddet, of Cubeside, Dalry, Ayrshire, a student of the West of Scotland Agricultural College, Glasgow. The value of the prize this year is about £6 10s., which is to be devoted to the purchase of books.

Rabies.—Since the last issue of the *Journal*, there have been no developments in the Middlesex and Berkshire districts. Two further cases, however, were confirmed on 10th June at Salisbury and at Chandler's Ford near Southampton, in the Wilts, Dorset, and Hampshire Area.

Foot-and-Mouth Disease.—*Ireland.*—On the 21st May the Ministry received information from the Irish Department of Agriculture that Foot-and-Mouth Disease had been confirmed at New Ross, County Wexford, and that an area of 15 miles radius therefrom had been scheduled for restrictions. The Ministry thereupon prohibited further landing of store stock from Ireland, but continued the existing provision for the landing of fat stock for slaughter within the landing places within 72 hours of landing.

The disease was confirmed among cattle which were practically grazing together, but owned by two people. Subsequently, on the 28th May, a further outbreak of disease was confirmed by the Irish Department in the same locality, and on the 2nd June disease was found to exist on a neighbouring farm. These later outbreaks did not, however, involve any extension of the Scheduled District.

On the 13th June, store cattle from parts of Ireland outside the 15 mile area, were admitted at certain landing places for 14 day quarantine in the landing place.

Great Britain.—The restrictions in connection with the outbreaks at Draycott (Derbyshire), Bebington (Cheshire) and North Runeton (Norfolk), referred to in previous issues of the *Journal*, have been withdrawn.

Yorkshire, Cheshire and Derbyshire.—The restrictions in connection with the outbreak of disease at Thurstonland, near Huddersfield, have now been withdrawn.

On the 18th May disease was confirmed at Harthill, Rotherham, on the Southern border of the West Riding of Yorkshire, and as a result the usual restrictions were imposed in respect of an area within a radius of 15 miles from that place. On the 22nd May the confirmation of disease on premises near Disley, Cheshire, necessitated the imposition of similar restrictions around Disley. Subsequently, disease was confirmed on ten other premises in Derbyshire, the latest of which was at Chapel-en-le-Frith on 7th June.

In view of the circumstances attaching to this extension of disease, restrictions were imposed as a precautionary measure over a much wider district so as to include the districts originally scheduled on account of the outbreaks at Harthill and Disley, and to comprise the whole of Derbyshire and Nottinghamshire, and portions of Cheshire, the West Riding of Yorkshire, Leicestershire and Staffordshire.

Within this district, two prohibited areas were described, one of about 5 miles radius surrounding Harthill, and the other including the farms in Cheshire and Derbyshire on which the remainder of the cases occurred, and to which the movement of animals by a dealer involved in one of the outbreaks had been definitely traced. In these two prohibited areas all movement of stock was suspended, with the exception of cases of special urgency, provision for which was made by the Inspectors of the Ministry. In the remainder of the extended scheduled district, movement into the district for immediate slaughter was permitted, as also the movement of animals within the district in cases of necessity, all such movements being by licence of an Inspector of

the Local Authority. The extent of this scheduled district was, however, considerably reduced as from 13th June by an order of the Ministry, one of the effects of which was to release from restrictions Derby, where the Royal Agricultural show was to be held at the end of June.

The origin of all these 12 outbreaks, most of which were discovered by the prompt action of the Ministry's Inspectors, has been due to the transactions of a dealer on whose premises one of the outbreaks occurred, and where the disease appeared to be of old standing. This dealer kept no proper record of his transactions, but animals were exposed by him at Chapel-en-le-Frith Market, Derbyshire, on the 5th and 10th May, at Macclesfield on the 6th May, and at Hayfield on the 12th May. No fewer than four of the eleven outbreaks occurred in animals exposed at Chapel Market on the 19th May. The original outbreak at Harthill occurred in animals which had passed through Marple Market, Cheshire, on the 2nd May.

Yorkshire (Otley District).—An outbreak of Foot-and-Mouth disease was confirmed on the 2nd June at premises near Otley. This outbreak owes its origin to contact with affected animals at one of the markets concerned in the Derbyshire outbreaks. The usual restrictions were imposed, and remain in force without modification.

Injurious Weeds Regulations, 1921.—With reference to the last paragraph of the notes on the suppression of weeds given at p. 275 of this *Journal* for June, regulations have now been made under Section 4 (10) of the Agriculture Act, 1920, declaring the following weeds to be the injurious weeds to which the sub-section shall apply :—

(1) Thistles *Carduus lanceolatus L.*—Spear Thistle.
Carduus arvensis Curt.—Creeping Thistle or Field Thistle.
(2) Docks *Rumex crispus L.*—Curled Dock.
Rumex obtusifolius L.—Broad-Leaved Dock.
(3) Ragwort *Senecio Jacobæa L.*

The position now is, therefore, that the Ministry of Agriculture may serve on the occupier of any land on which the above injurious weeds are growing, a notice requiring the destruction of such weeds.

Exportation of Horses and Conveyance of Horses by Railway.—The Diseases of Animals Act, 1910, as amended by the Exportation of Horses Act, 1914, prohibits the shipment of any horse, ass or mule, from any port in Great Britain to the Continent of Europe unless the animal has been examined immediately before shipment by a Veterinary Inspector appointed by the Ministry and certified by him to be capable of being conveyed and disembarked without cruelty, and also to be capable of being worked without suffering on arrival at its destination on the Continent. Provision has been made by the Ministry for the veterinary inspection of horses shipped under the above-mentioned Acts at the ports of London, Harwich, Hull, Goole, Folkestone, Southampton, Leith, Grimsby and Newhaven.

As it is of great importance that any illegal traffic in worn-out horses should on humanitarian grounds be prevented, the Ministry has asked Local Authorities of seaboard districts to co-operate with the Officers of Customs and Excise at the ports, with a view to prevent shipments of such horses contrary to the Acts, and the Board of Customs and Excise have agreed to assist by instructing their officers to notify to the Ministry and also to Local

Authorities any case in which it appears to them that the Acts are being contravened. This will enable action to be taken by the Local Authorities either to prevent illegal shipments taking place or to take legal proceedings against those found guilty of an infringement of the Acts.

The Ministry has further called the attention of all Local Authorities to the provisions of Articles 3, 4, 8 and 9 of the Horses (Importation and Transit) Order of 1913, which prohibit the carriage by water or by railway of any horse, ass or mule which, owing to infirmity, illness, injury, fatigue or any other cause, cannot be carried without unnecessary suffering during the intended transit.

Copies of a poster warning horse dealers and exporters of the requirements of the law in this matter can be obtained on application to the Ministry 10, Whitehall Place, London, S.W.1.

Leaflets issued by the Ministry.—Since the date of the list given on page 283 of the June issue of this *Journal*, two new leaflets have been issued and circulated :—

No. 367.—Wither Tip and Brown Rot in Plums.
„ 369.—Backyard Poultry Keeping.

The following leaflets have been revised and brought up to date :—

No. 8.—Assessments of Local Rates.
„ 19.—Pea and Bean Weevils.
„ 68.—Currant and Gooseberry Aphides.
„ 69.—The Lackey Moth.
„ 86.—Brown Rot of Apples.
„ 131.—Apple and Pear Scab.
„ 137.—Potato Scab.
„ 188.—Fumigation with Hydrocyanic Acid Gas.
„ 189.—Insurance of Farming Stock against Fire.
„ 193.—Dry Rot in Potatoes.
„ 234.—The Die-back Disease of Gooseberry.
„ 258.—Rural Party Line Telephones.
„ 265.—Rabbit Keeping.
„ 279.—Technical Advice for Farmers.
„ 282.—Scheme for the Improvement of Livestock.
„ 333.—Fish Meal as a Food for Livestock.

The following leaflets have been withdrawn from circulation :—

No. 47.—The Asparagus Beetle.
„ 90.—The Pith Moth.
„ 163.—White Rust of Cabbages.
„ 314.—The Manurial Value of Shoddy.

The following leaflets have been re-written :—

No. 49.—Bark Beetles and Shot Borers.
„ 115.—Coral Spot.
„ 278.—Linseed as a Farm Crop.
„ 304.—Husk or Hoose in Calves.
„ 354.—Jam-making.

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BREEDERS' ANNOUNCEMENTS.

CATTLE.

ABERDEEN–ANGUS.

MACAINSH, JOHN, Congash, Grantown-on-Spey, N.B. —Pure-bred Aberdeen-Angus Cattle.—Particulars on application.

DEVONS.

STANTON, HARWICH.—REGISTERED HERD RED DEVON DAIRY CATTLE. Devons are the best English Dairy Cattle under all conditions and in any climate.

FRIESIANS.

GILSTON PARK HERD OF PEDIGREE BRITISH FRIESIANS, property of A. S. BOWLBY, Esq. Bulls and Bull Calves generally for sale, by imported and other leading sires.—Apply Captain S. E. BUCKLEY, M.C., Gilston Park Estate Office, Harlow, Essex.

ROUGH HERD OF BRITISH FRIESIANS is the herd for production, colour, size, milk and butter-fat. The herd to buy your next bull calf sired by Routh Victory, third prize Dairy Show, 1920, weighing 13½ cwt. at 20 months old, whose dam gave 2,268 gallons, butter-fat 4 66 ; the only cow in the kingdom to produce 1,200 lb. of butter in 365 days. Inspection invited.—P. FORD, Molescroft, Beverley.

JERSEYS.

JEROME, MRS., BILTON HALL, TOCKWITH, YORKS. Pedigree Jerseys. Heifers and young Bulls for Sale.

SHORTHORNS.

WELBECK HERD OF PEDIGREE SHORTHORNS, the property of the Duke of PORTLAND, K.G. Young Bulls and Heifers for sale, from the best strains.—Apply, ALEX. GALBRAITH, Norton, Cuckney, Mansfield.

DAIRY SHORTHORNS.

HOBBS R. W., & SONS, Kelmscott, Lechlade.—500 Dairy Shorthorns ; milk records kept ; many firsts Royal and London Dairy Shows. Pedigree Bulls and Bull Calves. 4-cross Bull Calves at moderate prices, suitable for non-pedigree dairy herds.

PLAYFORD HERD OF PEDIGREE DAIRY SHORTHORNS. Deep-Milking Strains of robust constitution. Bulls in service : Thornby Don (133918). Hermit II. (120697). Milk records kept, inspected by Dairy Shorthorn Association and Ministry of Agriculture Recorder. Young Bulls and Bull Calves for sale. Also Breeder of Pedigree Suffolk Sheep and Large Black Pigs.—S. R. SHERWOOD, Playford, Ipswich.

CHIVERS & SONS, LTD., HISTON, CAMBS.—Pedigree Dairy Shorthorn Herd, numbers over 100 head, mainly composed of Bates and other old English Families. Winners at the Royal and leading Shows. Daily milk records checked by D.S.A. and Ministry of Agriculture Recorders. Young Bulls from recorded cows always for sale.

LINCOLN RED SHORTHORNS.

THE STAPLEFORD PARK HERD. A few young Bulls from Royal Prize Winners always for sale from carefully tested milking strains only. Apply C. S. Harvey, Wymondham, Oakham.

CATTLE—*continued.*

KERRY AND DEXTERS.

BRAISHFIELD MANOR HERD of Dexter Castle. Prizes won in 1915 include Championship R.A.S.E., Nottingham, first London Dairy Show.—Apply, Mr. W. A. OWEN, Elm Grove, Braishfield, Romsey.

PALMER, R. E. Pure Pedigree Kerry Cattle, Oaklands Park, Newdigate, Surrey.

HEREFORDS.

WHITE, W. J. S., ZEALS, WILTS.—Old-established Herd of Milking Herefords, Bulls and Calves, for Sale.

SOUTH DEVON.

GREENSLADE, W. R. J., 3, HAMMET STREET, TAUNTON, AND WELLINGTON, SOMERSET.—Sales of Devon Cattle, Dorset Horn Sheep, &c.

SHEEP.

OXFORD DOWN.

AKERS & CO., BLACK BOURTON, OXON.—Registered Oxford Downs, Rams and Ewe Lambs on Sale; inspection invited.

LINCOLN LONGWOOL.

HOYLES, GEO., SKIDBY MANOR, near HULL.—Pure Lincoln Longwool Sheep; true type, sound conditions, lustrous long wool, give satisfaction at home and abroad.

PIGS.

BERKSHIRE.

BRAISHFIELD MANOR HERD OF BERKSHIRE PIGS. Boars in use: Little John, Champion R.A.S.E., 1915, etc.; also Hugo, whose stock sold so well at Mr. Hiscock's Sale. Young stock of the best blood always for Sale.—Apply Mr. W. A. OWEN, Elm Grove, Braishfield, Romsey.

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BY

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